INTEGRATED EDITION OF THE PETROLEUM ENGINEER

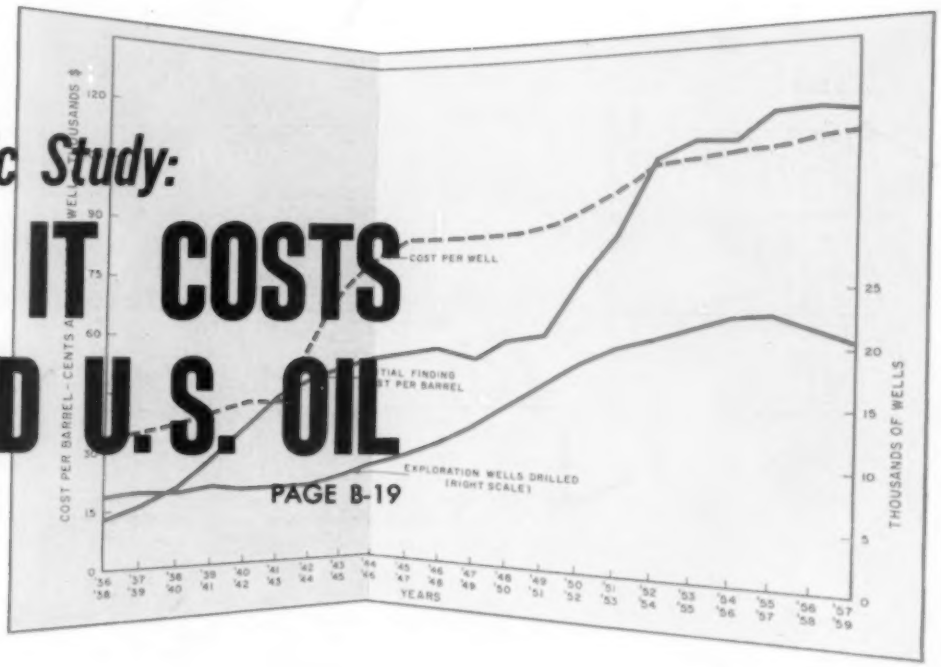
the Petroleum Engineer

FOR MANAGEMENT

NOV 1960

CONTENTS: 1 AD INDEX: 4

ONE DOLLAR PER COPY



An Economic Study:

WHAT IT COSTS TO FIND U.S. OIL

PAGE B-19

An Editor's View:
OIL POWERS EUROPE'S ECONOMIC BOOM E-1

Construction Report:
PIPELINE PACE QUICKENS AROUND THE GLOBE D-20

Technical Symposium:
WHAT'S HAPPENING IN CATALYTIC CRACKING C-19

Aluminum Pellets:
NEW IDEA IN HYDRAULIC FRACTURING B-40

SECONDARY RECOVERY--

EVEN MORE PROMISING

WITH DOWELL'S NEW IDEAS!

Many of the tools, techniques and products recently developed by Dowell for improving well stimulation treatments are being used effectively in *secondary recovery* operations. For example, *Rockshock** — a new service using implosion capsules to lower injection pressures; *Abrasijet** — a service used to clean the formation face and condition the zone for better fluid acceptance; *Ezeflo** — a low-pour-point surfactant used to lower water injection pressure; *Slick Water* — a friction-reducing agent used to cut pumping pressures by more than half during stimulation treatments; and a special agent used to remove calcium sulfate and other scale deposits from formations and down-hole equipment. These are only a few of Dowell's new services and products — more new ideas are on the way. If you're involved in secondary recovery work, it will pay you to *dial Dowell*. Dowell, Tulsa 1, Oklahoma.

*DOWELL TRADEMARK

Services for the oil industry

DIVISION OF THE DOW CHEMICAL COMPANY

DOWELL

THE PETROLEUM Engineer

FOR MANAGEMENT

NUMBER 12 • VOLUME XXXII • NOVEMBER, 1960

To Whom It May Concern: Tax Memo **A-20b**

Tax abuses in entertainment and employee expense account reporting have continued—even with the recent crackdown of the Internal Revenue Service.

E SECTION FOLLOWS A

Petroleum Powers Western Europe's Economic Boom **E-1**

First-hand observations of a two-months' study of the petroleum complex where politics and government interests play a most significant role.

— Ernestine Adams

Learn to Be Creative **E-4**

How to be a manager includes creativeness as the fundamental requisite and is vital to the preservation of a free enterprise society.

— Jack C. Vaughn

Dilemma of Oil Industry From Broker's Viewpoint **E-18**

International oil pricing policies are hard to understand, but they do have underlying implications for investors.

— A. Rhett duPont

The Art of Making 'No' Sound Like 'Yes' **E-20**

You have to say NO nearly every day and the way you say it may mean your success or failure.

At Presstime A-2
Highlights and Footnotes A-3
Advertisers' Index A-4
Course of Oil A-6
Petroleum Profile A-8
Conference Table A-10
Meetings E-15
Laugh With Barney E-19
Management Personals E-22
Books to Read E-27
Of Things to Come in Oil B-3
What's Doing in Drilling B-96
Exploration Activities B-100
Suppliers' Parade B-109
Running Tour B-112
Drilling and Producing Literature B-112
Drilling and Producing Equipment B-118
Petro/Chem Equipment C-64
Petro/Chem Newsmakers C-68
Pipeline Projects D-68
With the Pipeline Contractors D-72
Pipeline Personals D-77
Pipeline Parade D-81
Pipeline Equipment D-85
Pipeline Literature D-88

Copyright 1960 The Petroleum Engineer Publishing Company

Indexed by Applied Science and Technology Index, The Engineering Index, Inc. and Chemical Abstracts

The Petroleum Engineer for Management, published monthly, August through June, semi-monthly in July by The Petroleum Engineer Publishing Company, 800 Davis Building, Dallas 2, Texas. Subscription rate to the petroleum industry, United States, Canada, and foreign, $4.00 per year; $7.00 for 2 years; $9.00 for 3 years; $1.00 for single copy. Entered as second-class mail matter May 1, 1932, at the post office in Dallas, Texas, under the act of March 3, 1879.

DRILLING AND PRODUCING

What It Costs to Find U.S. Oil B-19
— H. J. Struth

Giant Texas Panhandle Oilfield at the Crossroads B-27
— Bryan L. Denson

A Practical Look at Slim-Hole Drilling B-34
— B. A. Aggers

New Fracture Propping Process Uses Aluminum Pellets B-40
— J. E. Kastrop

Aluminum Drill Pipe Extends Rig Depth Rating B-52

135 Cu Ft Gas Lifts One Barrel Fluid at Delhi B-54
— Luther F. Ellison

Mobile Underwater Storage Unit Built B-84

Movie Helps Contractor's Opportunities B-88

Well Completed on Ocean Bottom B-90

FPC Decision Reviewed by Investment Group B-95

PETRO/CHEM ENGINEER

Catalytic Cracking, Part I

W. E. Askey - W. J. Service, Special Issue Editors C-19

Highlights for HPI ... 2nd International Congress on Catalysis C-20
— Dr. Heinz Heinemann and W. E. Askey

What You Should Know About Catalytic Cracking C-24
— J. F. Crocoll and R. D. JaQuay

Characterization and Preparation of Catalytic Cracking Feed Stocks .. C-31
— W. J. Service

Catalytic Cracking Process Design C-37
— W. C. Chatman, C. W. Chen, and G. T. Atkins

Moving Bed Catalytic Cracking C-41
— A. Wesley Hoge, R. E. Ashwill, and E. A. White

PIPELINE ENGINEER

Global Aspect Steps Up Pipeline Pace D-20
— Frank H. Love

Contractor Views Equipment Maintenance Vital to Profits D-32
— Frank H. Love

Heavy Cement Coating Solves Soil Condition Problems D-35
— Lee J. Moremen and Joe R. Williams

Good Year Shaping Up for Canada D-38
— Leslie Orr Rowland

European Pipelines Planned on International Basis D-46
— F. C. Livingstone

Mid-America: Only System Designed Solely for LPG D-56
— Frank H. Love

at presstime . . . *a last minute round-up of petroleum industry news*

Standard of Cal merges subsidiaries into a single organization to be known as California Oil Company. The Standard Oil Company of California subsidiaries to be merged into a single organization are: Standard Oil Company of Texas, of Houston; California Oil Company at Perth Amboy, New Jersey; Salt Lake Refining Company at Salt Lake City, Utah; and The California Company at New Orleans, Louisiana.

10.7% more for product and process development in 1960 than last year is the finding of the American Management Association who surveyed some 400 corporations, representing 26 industry groups. Of this number, 66% increased their budget, 7% decreased their development budget and 27% reported no change. The 400 corporations spent an average of 3.7% of 1959 sales for product research and development that year.

There will be 16,000,000 compact cars on the road by 1965, but gasoline sales should continue to enjoy a healthy growth rate, in the opinion of C. H. Coughlin, vice president-marketing for American Oil Co. Even with compacts the industry will sell over 1 3/4 billion bbl of gasoline in 1965, an increase of 14% over 1960 sales and only 3% below what the figure would be if there were no compacts.

Present drilling rates must be increased 50% if we are to obtain the supply of gas needed to meet the increased demands of the '60s, David T. Searls, vice president and general counsel of Gulf Oil Corporation, told members of the Independent Natural Gas Association of America. This will mean drilling 625,000 wells during the 1960-70 period, he said.

Rep. Oren Harris of Arkansas, chairman of the House Interstate and Foreign Commerce Committee, will sponsor a bill at the next congressional session to stop off-the-record contacts between industry representatives and regulatory commissioners while cases are pending. He so told members of the Independent Natural Gas Association of America meeting in Miami Beach, Florida.

Oil is likely to play an important part in future steel manufacturing. Esso Research and Engineering Co. has developed an injection and control system which makes it possible, by feeding oil into the bottom of blast furnaces, to increase iron production and lower costs. Oil, which contains hydrogen, contributes additional "reducing" gas to speed the reduction of ore into iron.

Fire-fighter Myron M. Kinley received the Fifth Class of the Order of the Rising Sun, Japan's highest decoration and one rarely given, for his squelching of a natural gas fire in a Nagaoka City field recently. Typically, Kinley had to cut short congratulatory festivities after the presentation in Houston to dash for another fire — this time in Canada.

A record of 221,900,000 bbl has been produced during 1960 by Arabian American Oil Company. Production ran 12.8% in the first quarter and 15.5% in the second ahead of 1959. Aramco announced that on June 13 it produced its 4 billionth bbl of crude oil, thus placing Saudi Arabia in the company of the United States, Venezuela, and the Soviet Union as the only nations to exceed this mark.

THE PETROLEUM ENGINEER PUBLISHING COMPANY

800 DAVIS BUILDING, DALLAS, TEXAS. CABLE ADDRESS: PEPUB

Ernestine Adams — Management Editor
Frank H. Love — Editor, Pipeline Engineer
J. C. Webb — Editor, Petro/Chem Engineer
Lowell A. Murphy — Asst. Ed. Drilling/Producing
Walter A. Hogan — Field Editor
Lynn Patton — Editorial Production Manager
Linda L. Daily — Editorial Assistant
Donald D. Fickert — Presentation Editor

Allen K. Tyler — Production Manager
Jack H. Selby — Assistant Production Mgr.
Glen D. Hebert — Advertiser Services Mgr.
Sherwood R. Entwistle — Circulation Director
Royal Courtney — Circulation Manager
Harold L. Seamans — Circulation Field Service

Joe B. Woods — President and Publisher
Abbott Sparks — V.P. and Advertising Director
E. V. Perkins — V.P. and Western Manager
J. E. Kastrop — Editorial Director
L. H. Johnston — Secretary-Treasurer
Roland D. Carpenter — Controller

MEMBER OF
AUDIT BUREAU OF CIRCULATIONS
ASSOCIATED BUSINESS PUBLICATIONS

NEW YORK — John L. McDonald, Lansing T. Dupree
52 Vanderbilt Ave., MUrray Hill 6-7232
CHICAGO — E. V. Perkins, H. G. Fitzpatrick
53 West Jackson Blvd., HArrison 7-6883
LOS ANGELES — Richard P. McKey, Bruce Berkey
465 Converse Pl., Pasadena MUrray 1-0685
CLEVELAND — Paul J. Mansfield
1010 Rockwell Ave., TOwer 1-4231
HOUSTON — Jess Adkins
2370 Rice Blvd., Room 110, JAckson 6-2631
DALLAS — Ed Seeley
800 Davis Building, Riverside 8-4403
BIRMINGHAM — Fred W. Smith
1201 Forest View, Vesthaven TRemont 1-5762
UNITED KINGDOM—Kenneth S. Brooks
10 Gilbert Place, London, W.C.I.
W. GERM. - HOLLAND—Norbert Woelfl
Lohernockenstrasse 18, Ennepetal-Voerde, Germany

highlights *and footnotes of the news*

Humble-Monterey deal all set, whereby Humble Oil & Refining Company of Houston, Texas, will purchase outright for cash all the business and assets of Monterey Oil Company of Los Angeles, California, according to a joint announcement by Howard C. Pyle, Monterey president and Morgan J. Davis, Humble president. Subject to stockholder approval, each share of Monterey will come to an ultimate total of about $42 per share. Monterey, according to Pyle, will not sell to Humble its holdings in Transwestern Pipeline Company. These holdings, valued at about $13 million might be sold for cash but probably will be distributed to present Monterey stockholders. Deal will be closed not later than February 1st.

Russian oil for Italy in the amount of over 91 million bbl over a four-year period, according to an agreement announced recently by Tass, Soviet news agency. Under terms of the $200 million trade pact, Italy will supply Russia 240,000 tons of steel tubes, oil pipeline equipment and 50,000 tons of synthetic rubber.

4th quarter residual import quotas less than 1959. Residual imports allocated by the Department of the Interior total 415,000 bbl daily, exclusive of imports for bunkering and military re-export. For the same period 1959, quotas were 434,000 bbl daily, and 395,000 bbl daily for 4th quarter in 1957.

Oil union votes for 18 cent raise when contract negotiations get underway in December. O. A. Knight, head of the Oil, Chemical and Atomic Workers Union announced at Denver that ¾ of the local unions voted in favor of a proposed national bargaining program calling for an 18 cents an hour general wage increase. About 100,000 oil-industry workers, most of them in refineries, are represented by OCAW.

Eugene Holman to get highest industry award, the API's gold medal for distinguished achievement, which will be presented November 16 at the 1960 annual meet in Chicago. Holman, 40-year veteran oil man, retired last spring. A native Texan, he was former president and board chairman of the Standard Oil Company (New Jersey) now Humble Oil & Refining Company.

Western Gulf changes its name to Gulf Oil Corporation of California, according to an announcement by A. M. Bell, Jr., vice president in charge of operations. Under its new name, the corporation will operate in Alaska, Arizona, California, Nevada, Oregon and Washington. Headquarters will be in Denver, Colorado.

Crude prices firmer, some go higher. Indicators for firmer crude prices are making themselves known through announced increases. Standard of California boosted by 10 cents per bbl maximum the price it pays for heavier crudes starting at 14 API gravity and ranging down to 1 cent at about 22 gravity. The increase was followed by Union Oil of California for a 10 cent a bbl boost on 14 to 15 gravity and lower, with other increases ranging down to 1 cent a bbl on oils of 20 to 24 gravity. Richfield was also expected to follow the boost. Also, Derby Oil & Refinery Company of Wichita, Kansas, raised its crude purchase price by seven cents a bbl for top-grade 40-gravity crude, bringing it to $2.77. Both Standard Oil (New Jersey) and Shell International raised Mid-East crude prices. Shell's increase was from two to four cents per bbl (last August, it cut Mid-East crude from 8 to 14 cents a bbl). Jersey Standard boosted its price from one to four cents per bbl to lead the Mid-East price raise.

Petroleum demand highest in western states, according to R. G. Follis, board chairman for Standard Oil Company of California. Civilian consumption so far this year is 7% higher in the west than it was last year, while the national average was on the order of a 4% increase over last year.

New gas bill chances not improved by the Federal Power Commission's area gas pricing policy recently adopted as an outcome of the six-year old Phillips Case. The new "area pricing" policy though subject to further hearing as to specific prices established, overcomes much of the confusion of the log-jam on pending field price hearings formerly heard on a company-by-company basis in accordance with "cost of service" utility type of regulation. Industry leaders view the new area pricing policy as weakening its case for a new gas bill to clear up the confusion, although IPAA has gone on record saying that they are being led "from one system of confusion to another."

ADVERTISERS' INDEX

— A —

ACF Industries, Incorporated — W-K-M Division B-51, C-8, D-47
The Air Preheater Corporation D-12
Ajax Iron Works B-11
Allis-Chalmers D-4, D-5
American Institute of Chemical Engineers C-55
American Machine and Foundry Company, The J. B. Beaird Company, Incorporated, Subsidiary E-10, E-11
American Meter Company A-20, E-25
Anaconda American Brass Company C-66
The Annin Company C-3
Aquaness Department, Atlas Powder Company B-3
The Arlington Hotel and Baths E-26
Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division D-1
Automatic Electric, Subsidiary of General Telephone & Electronics .. D-16, D-17

— B —

Baash-Ross Division of Joy Manufacturing Company B-98, B-99
The Babcock & Wilcox Co., Boiler Division C-7
Refractories Division C-59
Baker Oil Tools, Inc. B-18, B-41, B-113
Barber-Greene D-78, D-79
Baroid Division, National Lead Co. .. B-64, B-65
The J. B. Beaird Company, Incorporated, Subsidiary, American Machine and Foundry Company E-10, E-11
Bethlehem Steel Company D-10, D-11
Brakesol, Inc. B-123
Burgess-Manning Co. E-21
Byron Jackson Tools, Inc., a Subsidiary of Borg-Warner Corporation B-67

— C —

Cabot Corporation, Machinery Division B-1, B-17
Cameron Iron Works B-94
Caterpillar Tractor Company E-14
Cherokee Laboratories, Inc. B-63
Classified Advertising E-25
Clayton Mark & Co. E-16, E-17
The Cleveland Trencher Co. D-13
Climax Engine Manufacturing Co., Division of Waukesha Motor Co. B-111
Collins Radio Company, Texas Division Sales A-20g
The Colorado Fuel and Iron Corporation B-116
Continental-Emsco Company, a Division of The Youngstown Sheet and Tube Company B-45, B-46, B-47, B-48
Continental Oil Company B-56
Cooper-Bessemer Corporation C-60, C-61, D-60, D-61
Core Laboratories, Inc. B-101
Crane Packing Company C-58
Crose-Perrault Equipment Corp. A-20e
The Crosszatt Company, Chemical Division . B-102
Crutcher-Rolfs-Cummings D-84

— D —

De Laval Steam Turbine Company C-10, C-11, D-15
Dempster Brothers, Inc. E-9
Dowell ..... Inside Front Cover, A-13
Dragon Engineering Co., Inc. E-26
E. I. Du Pont de Nemours & Co., Inc. C-18
Duralmetallic Corporation C-69

— E —

Engelhard Industries, Inc. C-54b
Engineering Enterprises B-119
Ethyl Corporation C-4, C-5

— F —

Fleetline Co. D-90
Flight Refueling, Inc., Commercial Products Section C-67
The Foxboro Company D-3

— G —

Gardner-Denver Company B-77
Gaso Pump & Burner Mfg. Co. D-2
General American Transportation Corporation, Plate & Welding Division A-19
General Electric
Small AC Motors & Generator Department B-81, B-82
Gas Turbines D-6, D-7
W. R. Grace & Co., Davison Chemical Division C-13
Graver Tank & Mfg. Co., Division, Union Tank Car Company C-12
Greenlee Tool Co. C-70
The Guiberson Corporation B-13
Gulf Oil Corporation E-6, E-7
D. W. Haering & Co., Inc. E-23

— H —

Halliburton Company ..... B-86, B-87, B-97, Back Cover
Handley-Industries, Inc. D-76
Harbison-Fischer Mfg. Co. B-109
The Harshaw Chemical Company C-54
Hercules Powder Company C-69
H & M Pipe Beveling Machine Co. D-85
Hotel Pittsburgher E-25
Houdry Process Corporation C-58, C-65
Houston Contracting Company D-14
Hughes Tool Company B-104, B-105
Hydril Company B-37, D-43

— I —

Insley Manufacturing Corporation D-18
Instruments, Inc. B-95
The International Nickel Company, Inc. ... B-72

— J —

Jensen Bros. Mfg. Co. B-118
Johns-Manville Products D-48, D-49
The S. M. Jones Company, Division of Buffalo Eclipse Corporation B-114
Jones & Laughlin Steel Corporation .. B-92, B-93

— K —

Kellogg Switchboard & Supply Co. D-53
Koch Engineering Company, Inc. A-20f

— L —

Lane-Wells Company ..... Inside Back Cover
Larkin Packer Company, Division Koehring Company B-79
Leland Equipment Company D-80
Liberty Manufacturing Company of Texas . B-49
J. E. Lonergan Co. E-19
Lone Star Steel Company A-7

— M —

Mack Trucks, Inc. B-10
Maloney-Crawford Tank & Manufacturing Company, Inc. B-91
Manzel, a Unit of Houdaille Industries, Inc. E-20
Marsh Instrument Company, Division of Colorado Oil and Gas Corporation A-17
John N. Martin, Manufacturer B-118
Martin-Decker Corporation B-123
C. A. Mathey Machine Works, Inc. D-88
Mavor-Kelly Company D-88
Mercantile National Bank E-26
Mid-Continent Supply Co. B-14
Mission Manufacturing Co. B-61
Motorola Communications & Electronics, Inc. D-63

— Mc —

McCord Corporation D-90
McCullough Tool Company B-43
McGaffey-Taylor Corp. B-123

— N —

The National Supply Company, Subsidiary of Armco Steel Corporation B-57, B-58, B-59, B-60
National Tank Company E-28
Nee & McNulty, Inc. D-83
W. C. Norris, Manufacturer, Division of Dover Corporation B-122, B-124

— O —

Oakite Products, Inc. .. B-117, C-14, C-15, D-86
Oil Center Tool Co. B-83
Oil and Petroleum Year Book E-27
Oil Well Supply Division of United States Steel A-9, B-39
Otis Engineering Corporation B-76, B-120

— P —

Pacific Moulded Products Co. B-117
Pacific Pumps, Inc. B-121
Parker Seal Company, a Division of Parker-Hannifin Corporation A-14, A-15
Parsons Company, a Division of Koehring Co. D-81
Peerless Manufacturing Co. A-11
Penberthy Manufacturing Company, Division of Buffalo-Eclipse Corporation . D-87
Pipe Linings, Inc., a Subsidiary of American Pipe and Construction Co. .. A-20h
Pipeline Inspection Co., Inc. D-90
Pittsburgh Chemical Company D-89
Polyken Products, Division of The Kendall Co. D-55
The Wm. Powell Company A-20d
Procon Incorporated C-6

— R —

Radiator Specialty Co. C-69
Raybestos-Manhattan, Inc., Manhattan Rubber Division C-68
Raytheon Company, Equipment Division .. D-57
The Rector Well Equipment Company B-89
Reda Pump Company B-110
Reed Roller Bit Company B-70, B-71
Reilly Tar & Chemical Corporation D-77
Republic National Bank of Dallas A-5
Rockford Clutch Division, Borg-Warner .. B-90
Rockwell Manufacturing Co. A-20a, B-9
John A. Roebling's Sons Division, The Colorado Fuel and Iron Corporation .. A-16

— S —

Salt Water Control, Inc. B-106
Schlumberger Well Surveying Corporation B-115
Security Engineering Division B-44
Seiscor, a Division of Seismograph Service Corporation E-25
Servco B-69
Servis Equipment Co. D-44
Shaffer Tool Works B-85
Shell Oil Company A-18
M. B. Skinner Co. C-70, D-86
A. O. Smith Corporation, Smith-Erie Division B-6, B-7
Socony Mobil Oil Company, Inc. C-16, C-17
Standard Oil Company (New Jersey) E-13
Standard Pipeprotection D-74
Steel Forgings, Inc. D-82
Stephens Engineering B-124
Sun Ship Building & Dry Dock Co. C-1

— T —

The Tapecoat Company D-65
Techno Corporation E-24
Teletype Corporation, Subsidiary of Western Electric Company, Inc. D-19
Texas Electric Service Company D-67
Texas Iron Works B-80
Tretolite Division of Petrolite Corporation B-8, C-9
Trinity Portland Cement Division, General Portland Cement Company B-4

— U —

UGC Instruments, a Division of United Gas Corp. E-12
United States Steel Stainless Steel B-103, C-56, C-57
Universal Inspection & Service Co., a Division of Atlas Pipe, Inc. B-108
Universal Oil Products C-62, C-63, D-9

— V —

Victaulic Company of America E-15
Visco Products Company, Inc. B-112
Henry Vogt Machine Co. C-2

— W —

Walworth Company, Lubricating Plug Valve Division D-75
Warner-Lewis Company D-8
Washington Iron Works, Inc. D-82
Waukesha Motor Company B-15
Welex, Inc. B-2
Well Equipment Mfg. Corp. B-75
Western Gear Corporation, Industrial Products Division D-69
Western Supply Company C-64
Frank Wheatley Pumps & Valves E-22
The Wheland Company B-53
Wheeling Machine Products Company E-24
Wilkinson Products Company D-72
Williams Brothers E-26
Williams Pressure Service Company D-73
T. D. Williamson, Inc. D-71
Wilson Supply Company B-16
Wisconsin Motor Corporation B-107
W-K-M Division of ACF Industries, Incorporated B-51, C-8, D-47
Worthington Corporation D-51

THIS INDEX IS PROVIDED AS AN ADDITIONAL SERVICE FOR OUR READERS — THE PUBLISHER ASSUMES NO RESPONSIBILITY FOR ERRORS OR OMISSIONS

RHIA [RANK HAS ITS ADVANTAGES]

For decades, oil and gas men have turned to the Republic for the many varied and special bank services they require. Republic knows you must have accurate fact and figure data, prompt decisions on financing, and frequently, bank counselling with your lawyer on regulations and tax matters.

As a pioneer oil bank in the South . . . with the South's largest Oil and Gas Department, Republic is uniquely equipped by experience, knowledge and resources to give you the complete, specialized service you need.

Doing business with Republic Bank indeed has its advantages and they are in your favor. Next time, talk to Republic, indisputably a leader in the field of oil and gas financing. We're here to serve you.

REPUBLIC NATIONAL BANK
OF DALLAS

"My Bank" to the Oil and Gas Man

MEMBER, F.D.I.C.

CAPITAL AND SURPLUS $102,000,000 — LARGEST IN THE SOUTH

It's your fight, too

WE ARE CONSTANTLY reminded at industry gatherings, both large and small, by oil trade publications, by newspapers, by your own company magazine, and even in memoranda . . . that the petroleum industry is having a tough time making ends meet. Overall profits which help pay for expansion . . . new plants, more wells, pipelines, exploration programs . . . are low. Crude oil prices have been cut in numerous areas, gasoline wars persist, product prices are low, crude oil production per well has declined, federal control of gas prices, both at the wellhead and over the ultimate sale price, is unrealistic. And the payout period for plants, pipelines, new wells, and recovery programs is growing longer and longer.

In the face of this, the cost of doing business . . . any kind of business . . . is constantly going up. Wages continue to rise, cost of material grows every day. It costs more to build anything, wells cost much more, it costs more to transport crude and products, and to sell what we produce and make.

You may say, this is the problem of management . . . of the high-salaried executives . . . of those who go to Harvard and other institutes of higher learning . . . who are paid to solve these economic and business problems. Let them do their job . . . and, I'll do mine, you may say. Let them figure out how to develop new markets . . . let them do all the lobbying in Congress for a more favorable legislative climate for petroleum . . . let them figure out how to cut expenses . . . let them do without company cars . . . company airplanes . . . let them worry about where, when and how to cut down expenses.

No matter what company you work for, you can be sure your management has been doing just that for a number of years. And, some of their long-range thinking, investigating and planning have become quite well-known. We've seen company mergers, one after another, and they're still going on. We've seen consolidations, streamlining, reduced budgets, and . . . yes . . . some layoffs.

But . . . stop for a minute, and take stock.

Just who is management? Who are the executives? Who makes all the decisions?

In many respects we are all a part of management by the very definition of the word. In small or big ways, we all make decisions.

Examine your own job carefully. Is it so cut-and-dried that you have no room at all for some individual thinking? Have you been shut out entirely from making suggestions, from acting, from doing?

Those at the top of your organization who have the titles cannot possibly come up with all of the answers needed to keep the petroleum industry healthy, vigorous and growing.

Every employee must do his part . . . from the clerks who buy office supplies, those who make long-distance telephone calls . . . those who design and build multi-million dollar projects . . . all have a role. A dollar saved here and there, a way to do a better job at less cost . . . elimination of surplus "fat" from our operations . . . giving a full day's work for a day's pay . . . being proud to be a part of this dynamic industry . . . are a few ideas you can kick around.

Management needs your help, for you are in many ways a part of running your company. The titled executives cannot do the job from their offices. They need your help . . . it's your fight, too.

J. E. Kastrop

Congrats and $25 to R. STROHMEYER, J. M. Huber Corp., Borger, Texas

When it comes to blowing our own horn . . . We believe it is done best by delivering pipe of quality, stamina and dependability. Lone Star, the oil country's own steel mill . . . does just that on a round-the-clock basis.

The Lone Star plant embodies the most advanced techniques in making casing, tubing, and line pipe to exacting API specifications.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.

Lone Star STEEL COMPANY

© 1956 Lone Star Steel Company

EXECUTIVE—SALES OFFICES
W. Mockingbird Lane at Roper · P. O. Box 12226 · Dallas, Texas

DISTRICT SALES OFFICES
912 Republic National Bank Building, Dallas, Texas
Houston, Texas | Midland, Texas | Tulsa, Oklahoma

petroleum profile

IT DOESN'T SOUND especially remarkable that John Eldred Swearingen became chief executive officer of Standard Oil Company (Indiana) after 21 years' service with the company. But hear the rest: He reached this position before his 42nd birthday, and is one of the youngest corporate chief executive officers in the U. S. Now that is extraordinary.

"He's a shirt sleeves guy," said a reporter for a national news magazine, "but forthright, concise, deliberate, and quite mature."

These qualities grew from Swearingen's early years in Columbia, South Carolina, under the guidance of a mother and father who wanted their two sons and daughter to learn new things constantly and to stand on their own two feet. Before he was in his teens, Swearingen tackled the job of delivering newspapers in his home town, and during the depression years he held various money-making jobs to help finance his college education.

Education was much a part of the family concern. Swearingen's late father served for 14 years as South Carolina's

JOHN E. SWEARINGEN
President
Standard Oil Company (Indiana)

state superintendent of education. His mother was a visiting teacher and taught high school. John Swearingen's scholastic record, the honors and scholarships he earned must have been a great satisfaction to his parents.

He entered the University of South Carolina, where he studied chemical engineering, at the age of 16, and by the time he was 20 he held a master's degree from Carnegie Institute of Technology. In 1939, shortly after receiving his master's degree, Swearingen joined Standard Oil as a chemical engineer at its Whiting, Indiana, research laboratories. His parents had to sign a release on his first wages because of his age.

Swearingen held several positions successively in the research department until 1947. He had declined an administrative assistant's post with a company executive, but accepted a transfer to an operating position where he hoped to broaden his experience and knowledge. This sent him to the manufacturing department of Stanolind Oil and Gas Company, now Pan American Petroleum.

Promoted several times, he became a director of Stanolind in 1951. Later that year he returned to the parent company at Chicago as general manager of production and the following year became a director of Standard Oil Company. In 1954, he was elected vice president in charge of production. Two years later he became an executive vice president.

At the age of 39, in 1958, Swearingen was elected president of Standard Oil Company (Indiana).

The impressive achievement of the young president is that he began as a researcher, looked upon as ivory-tower seclusion, and in a comparatively short time familiarized himself with the many aspects of a large integrated oil company.

When the opportunity permits, Swearingen enjoys hunting, trap shooting, fishing, and golf. He lives in a northwestern suburb of Chicago, Glenview, with his wife, the former Rolly Osterberger of New Orleans and Baton Rouge, Louisiana, whom he married in 1942, and their three daughters, Marcia, 15; Sally, 11, and Linda, 7.

His busy work schedule does not keep him from attending some school events in which his daughters participate. At one such affair a company employee approached Swearingen and introduced himself, and related afterward, "He was just like any other father there. Maybe he was a little more reserved, but we talked for several minutes about our children and the school program."

Swearingen is a member of Phi Beta Kappa and Tau Beta Pi. He holds an honorary engineering degree from South Dakota School of Mines and Technology.

As a corporate executive and the chief executive officer of Standard Oil Company, he has a deep personal feeling for the future of the country and the role of free enterprise. Swearingen makes relatively few speeches, but those he has made have a continuing theme seeking solutions to inflation, federal government interference with business, and the impediment to progress by interference with the full use of new technology. He is a champion of research, both applied and exploratory, from which he says new ideas, new processes, and new products flow despite the fact that "it is sometimes difficult to see a direct relationship between specific basic research projects and eventual commercial application."

He has evidenced concerned interest in the effect automation has, both on the improvement of the profits and its effect on people it may displace. In one of his major speeches he made the comment that "it's no good just to tell an employee that 15 years from now greater industrial production will provide for him and his children new opportunities for a much richer way of life. He needs help today and next week, if he's to get to that promised land 15 years from now. Adequate severance pay, practical assistance in finding a new job, community effort to cushion the strains of displacements and relocations—these and other things must be provided for all those who are temporarily distressed by the new (industrial) revolution."

Swearingen sees as the challenge industry must meet for continued success the recognition of its responsibility to manage effectively and efficiently, but with flexibility to cope with a changing society.

He is an advocate of greater participation in politics by employees and businessmen in the party of their choice. "In this attitude of mature acceptance of reality and the responsibility it imposes lies the real hope of our future," is his conviction.

This is a guiding principle he now has the opportunity to employ as he takes the next step in his career as president of Standard Oil Company (Indiana) and, since August 25, 1960, chief executive officer.

6,500-ft. string of "Oilwell" Grade "Y" Sucker Rods runs 3½ years with only one broken rod

Mid-Continent producers are familiar with the rod-breakage problems encountered in the heavily-loaded wells at Oklahoma City . . . and should carefully analyze this report on "Oilwell's" Grade "Y" Sucker Rods.

The string was installed on November 11, 1956, in the well shown, and operates a 1½-inch pump at 16 spm with 74-inch stroke at a 6,500-foot pump setting, to produce approximately 300 bpd. The well weighed 21,300 lbs., stressing the rods to 27,100 psi. The only rod break occurred at an elevator shoulder and was attributed to elevator damage.

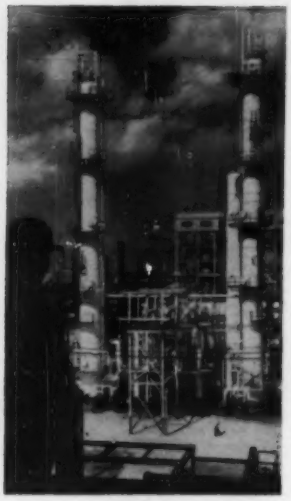
The secret of Grade "Y" Sucker Rods is in their elastic strength, which gives them unmatched fatigue resistance. High elastic strength comes from a touch of boron, a careful liquid quench and thorough shot peening. The result is . . . sucker rods that carry repeated stresses beyond the point where "hard" rods give up . . . and last many months longer than the so-called "high strength" rods.

Grade "Y" Rods are your best buy for deep wells (non-corrosive or inhibited) where a wide range of repeated stress is encountered. They can be ordered with standard or slim-hole Grade "S" or CO-HARD couplings. Talk it over with your "Oilwell" representative and make your own test by running a string in your next well.

USS, "Oilwell" and CO-HARD are registered trademarks

USS Oil Well Supply Division of United States Steel

Executive Offices: Dallas, Texas
Export Offices: 30 Rockefeller Plaza, New York 20, N.Y.



the conference table

How Much Exaggeration?

Nothing is more likely than the Soviet figures are on the high side. If you were commissar of petroleum in Uzbekistan, wouldn't you put the best statistics in your report that you thought you could get by with? If you want to keep your job, you will. There's no place for those who falter.

Correspondent James Morris of the Manchester Guardian, great English newspaper, recently visited Russia. In a dispatch he said: "You must take on trust . . . the staggering Soviet claims of industrial expansion, rocketry, atomic energy, agricultural initiative, and all the bragging that sometimes overcomes your Intourist guide. You cannot check for yourself. I will be bold and brash . . . I do not believe all the Russians say. I sniff at their statistics. There seems to be something illusory, deceptive, misleading in the air of Russia today, something that niggles at my intuitions and sharpens my skepticism."

"Some men are born great, some achieve greatness, and others just keep still." — Kin Hubbard.

Lift Your Eyes to the Long Term

Companies are warned not to watch the zig-zags of year-to-year economic movements for a nation or a company or an industry but to watch the long term trends. That's what Independent Petroleum Association of America provides in its annual review "The Oil Producing Industry In Your State" which has been published annually for 10 years.

IPAA shows the dramatic growth in the oil and gas producing industry with these figures:

At the end of 1949 there were 512,000 producing oil and gas wells in the United States. Producing wells totalled 675,789 at the end of 1959 — an increase of 32%.

Proved reserves of petroleum liquids rose from 28.4 to 38.2 billion bbl in the 10 years, or 34.5%.

Production of petroleum liquids increased 45% from 2.0 billion bbl in 1949 to 2.9 billion bbl in 1959, and natural gas output rose almost 100% from 6.2 trillion cu ft to 12.3 trillion cu ft.

Although 1959 was not the record year for drilling, total wells exceeded the 1949 rate of drilling by almost 30%. It is significant that average depth of all wells increased in the 10 years from 3538 ft to 4092 ft, reflecting both improved technology and the tendency to carry the search for oil deeper and deeper into the earth's crust.

The value of total oil and gas production in 1959 was $9.6 billion, as compared with $5.5 billion in 1949 — an increase of 75%. Petroleum fuels represented 52.0% of the total value of U.S. production of all minerals, metals and fuels in 1949 — and was the equivalent of 56.7% of the value of all these resources in 1959.

Oil and/or gas now are being produced in 33 of our 50 states. In the 33 states a total of almost 425 million acres are under lease with only 25 million acres already proved.

"Gratitude is the most exquisite form of courtesy." — Jacques Maritain.

Management Course in Brief

One of the best series we've seen for a simple, workable management course is that put out by the U. S. Air Force. It is called "Organizing Your Job" and is directed to Air Force working leaders, both military and civilian. Here are the 13 titles:

AFP 40-10-3, How to Receive, Analyze, and Plan Work Assignments
AFP 40-10-4, How to Assign Work, Check Work, and Make Reports
AFP 40-10-5, How to Induct a New Worker
AFP 40-10-6, How to Identify Training Needs
AFP 40-10-7, A Pattern for Instruction
AFP 40-10-8, Practicing Instruction Techniques (Workshop)
AFP 40-10-9, How to Appraise Work Methods
AFP 40-10-10, How to Improve Work Methods
AFP 40-10-11, How to Develop and Apply Better Work Methods (Workshop)
AFP 40-10-12, How Differences in Workers Affect the Job
AFP 40-10-13, How to Understand Workers
AFP 40-10-14, How to Apply Problem Solving Techniques to Human Relations Problems
AFP 40-10-15, How to Develop Your Leadership Ability

The 13 booklets above can be obtained for 20 cents each from the Superintendent of Documents, Washington 25, D. C.

"It is well for the heart to be naive and for the mind not to be." — Anatole France.

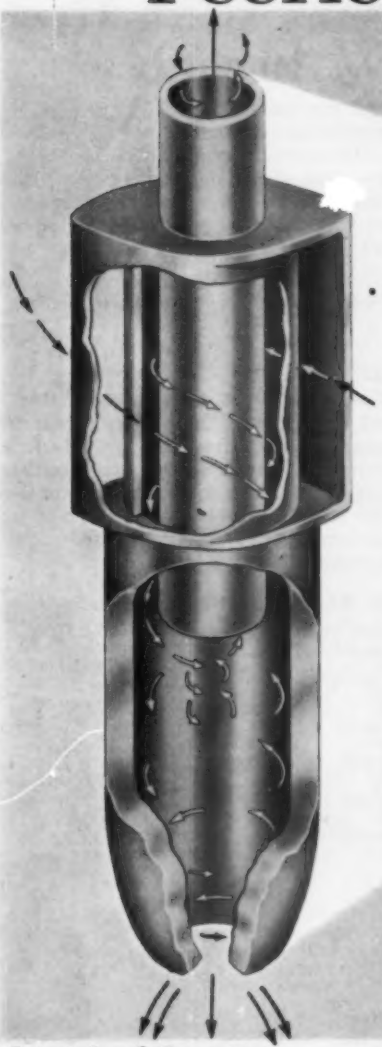
Playing It Safe . . .
. . . Against Job Accidents

- Ample and uncluttered work spaces.
- Effective control of toxic materials.
- Radiation safety measures.
- Aisles marked off for safe widths and traffic flow.
- Safe piling and arrangement of materials and tools.
- Slipping and falling hazards eliminated.
- Good illumination.
- Prompt clean-up of spills.
- Frequent clean-up of dust and scrap.
- Quick repair of leaks, damaged tools, and defective equipment.
- Regular training of work force in fire prevention and control.
- Fire-fighting equipment readily available and maintained in the best of condition.

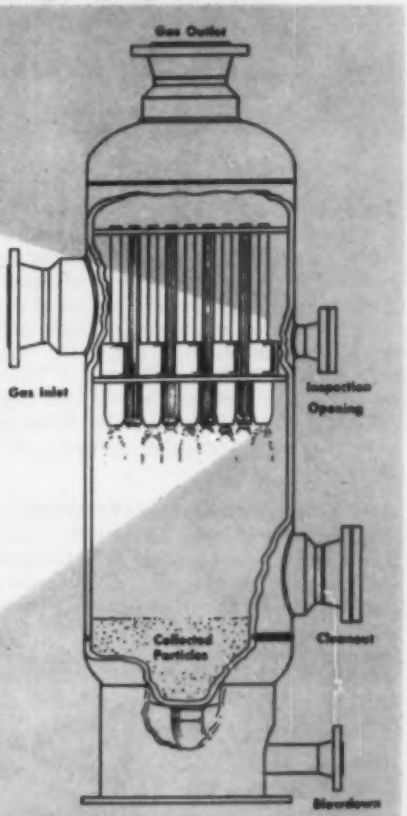
Taken from Annual Newsletter, December 1959 issued by the National Safety Council, Chicago, Illinois.

Another in a complete line of Peerless Scrubbers

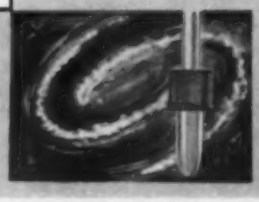
Peerless Dry Scrubber



...utilizes multiple cyclones to achieve high efficiency removal of troublesome dirt and liquid.



PEERLESS CYCLONE TUBE CONSTRUCTION . . . The cyclone elements are constructed of an alloy combining abrasion and corrosion resistance with shock-resistant qualities needed for reciprocating compressor station requirements.



Principle of Operation

The Peerless Dry Scrubber consists of small diameter cyclones in parallel to provide the centrifugal force necessary for efficient small particle removal at high pressures. Peerless Dry Scrubbers are offered in a complete range of sizes and working pressures to fit any scrubber requirements. Also available are compartmented scrubbers to handle the problems of widely varying flows with only one vessel where multiple scrubbers have been required heretofore. Write for descriptive literature.

Provides these important advantages

1. Efficient removal of dust and liquids.
2. Cannot be overloaded.
3. Uses no scrubbing oil, hence no oil loss.
4. Requires no oil filling or settling tanks.
5. Virtually maintenance free, requiring only occasional blowdown of collected material.
6. Ordinarily smaller and less costly than wet type scrubbers.

Engineering Assistance Available: Peerless makes all types of Scrubbers, including Dry Scrubbers, Oil Bath, both a fixed contactor type (Swirl-Gas Cleaner) and a revolving contactor type (Scrubosphere). In addition, Peerless makes Gas Filters. Ask us for recommendations on the type Scrubber best suited to your application.

SEPARATORS: Liquid Vapor
DUST SCRUBBERS: Wet and Dry Types
GAS FILTERS
GAS ODORIZERS
SILLERS CLOSURES
OTHER PRODUCTS: Engine Timers, Scraper Traps, Manways

PEERLESS MFG. CO. DALLAS, TEXAS

PEERLESS MFG. CO.

Representatives in All Principal Cities

P. O. Box 13165 • Dallas 20, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Supply and Demand

"Every year the world will require a million barrels a day more oil than it did the year before, and that is approximately what Saudi Arabia produced last year. The investment and the time required to develop oil for that increased demand each year is going to put enough drag on our industry to take care of this supply-and-demand problem. We think the tendency will be to strengthen the present relative price level at which our Company is earning in the range of $4 a share on its present volume." — Chairman R. G. Follis, Standard Oil of California.

Engineers Need Computer Instruction

"Engineering calculations of the future will be done by machines," two University of Michigan engineering faculty members declared at a meeting of American Society for Engineering Education. This means that engineering educators themselves must learn to teach computer usage and engineering schools must obtain the expensive machines, according to Professors Donald L. Katz and Elliott I. Organick. The professors agreed that engineering students should have solved — essentially as homework — eight to sixteen problems on the computer by the time they graduate.

Have You Noticed Michigan University?

If you want to know what public relations are all about take a look at the University of Michigan. Its News Service is making headlines in the daily press and in consumer and trade magazines. Sometimes it almost seems as if the public relations department is setting the projects for the university's research.

Seriously, the University of Michigan is to be congratulated on being able to get over into simple, readable news the landmarks of scientific and psychological research.

"He that falls in love with himself will have no rivals." — Benjamin Franklin.

Th's Looks Like a Lot of Gasoline

The number of motor vehicles in the world early in 1960 reached 117,788,400 (90,835,000 cars and 26,953,400 trucks and buses), according to The American Automobile. This is about 5% more than early in 1959 and 87% more than early in 1950 (63,200,500). Here are comparison figures for the two years:

	Early 1959	*Early 1960*
USA	67,824,700	70,234,300
Canada	4,700,600	4,941,000
Other Western Hemisphere	3,905,700	4,269,200
Western Europe	22,489,400	24,174,200
Non-Communist Asia	3,151,000	3,403,000
Africa	2,314,500	2,498,200
Oceania	3,255,600	3,402,900
Communist countries	4,505,700	4,865,600

A Conservative's Conscience

This being an election year, perhaps it is not so surprising that Senator Barry Goldwater's book "The Conscience of a Conservative" is now in its third printing. Few people call themselves conservatives in this day. Those who do evidently want to see the code of conservative belief collected under one cover.

As a whole, we would say the oil industry is politically conservative, and it may be because conservation has a different meaning to those in the oil industry. There is certainly no taint of regression or reaction to the theory of conservation of our oil and gas resources. This is the forward-looking, progressive view of petroleum operations.

Senator Goldwater's small book (Victor Publishing Co., Inc., 1 Fourth Avenue, Shepherdsville, Kentucky, price $3.00) is brief and easily read. It puts him in a class with professional writers.

Whatever party you belong to, this book is worth reading if for nothing else than to see clearly where and why you disagree.

Screws

A recent Air Force purchase of 272,710 screws at $1 each suggests the peculiarities of some armed forces procurement practices. The contractor paid only 5½ cents for each of the screws — even after negotiations began. The "screwy" $1 price was based on a previous emergency purchase of 116 screws which were shipped from Cleveland to New York by air special delivery.

✔ *We Americans need to decide what system we believe in.*

Who'll Do the Work?

This is an age of statistics. There are so many of them, of so many different kinds, that at times it seems we are in danger of drowning in a sea of statistics that threatens to engulf us on every side. Here are some statistics that have gone the rounds but you may have missed them. We will concede that the statistics in this case are wholly assailable, but the conclusion is one with which we sometimes find ourselves in agreement.

POPULATION BALANCE SHEET 10/1/58

Population of United States	175,000,000
Population over age 65	57,300,000
People left to work	117,700,000
People under age 21	64,700,000
People left to work	53,000,000
Government employees	24,000,000
People left to work	29,000,000
People in armed forces	12,000,000
People left to work	17,000,000
City and State workers	16,800,000
People left to work	200,000
Insane and in hospitals	126,000
People left to work	74,000
Bums and drunks	62,000
People left to work	12,000
In jails and prisons	11,998
People left to work	*2

*You and me, and you better get busy as I'm getting sick and tired of running this country alone.

A "Friendly Gesture"

Greif-Associates, Inc., New York, which does Engineering and Industrial publicity, recently supplied a free booklet on writing. When ours arrived it had this mimeographed note on the cover:

Attached . . .
is an item
which we thought might
be of some interest
to you.
Please consider
our sending it
as a friendly gesture,
a small service
we are glad to render.
No acknowledgment is
therefore necessary
or expected.
Cordially
Lucien R. Greif

We suggest it might be a good idea for companies sending free publications.

The booklet, by the way, was "How to Take the Fog Out of Writing" by Robert Gunning — something everyone who writes could use.

Good Wells Make Good News

Treatments that Improved Secondary Recovery and Water Disposal Wells

November, 1960

Every well on your lease represents an investment on which you hope to earn a profit, whether it's a disposal, injection or a producing well. If its performance can be improved at a reasonable cost, your net profits should also improve. Dowell treatments have made all types of wells more valuable to their operators. Here are four recent examples of how stimulation treatments by Dowell improved two waterflood producing wells and two water disposal wells.

- **Daviess County, Kentucky** (Waterflood producing well) This old well had been abandoned as depleted several years ago. Pay was the Cypress sand between 1365 and 1385 feet. When pool was converted to waterflood, well was cleaned and pipe was set for open-hole completion. Before treatment well made only a show of oil. Dowell treated, using Abrasijet* — abrasive jetting service, Waterfrac and temporary plugging material. Formation was jetted for 20 minutes using 5000 pounds sand, then fractured using water with FLA* and 10,000 pounds sand. Two batches of temporary plugging material were used during the treatment to obtain multiple fracturing. 30 days after treatment, production had stabilized at 35 bopd.

- **Montgomery County, Southeast Texas** (Salt water disposal well) This well had been completed into a Miocene sand between 3357 and 3368 feet. Before treatment, it would take no water (at pressures as high as 800 psi) so the operator ordered a 1000-gallon treatment using regular acid. There was no improvement. Dowell was consulted and recommended treating with 1000 gallons Super Mud Acid. Since the sand was believed to be oil-wet, an extra amount of surfactant was used. During treatment, the well went on vacuum. At last report, it was accepting all available water.

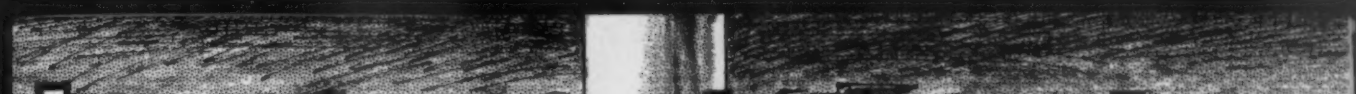
- **Lea County, New Mexico** (Water disposal well) This well had been completed open hole into the Devonian between 12,207 and 12,463 feet. Before treatment, it was receiving 28 bwph at 4500 psi. Dowell acidized, injecting 10,000 gallons regular acid down 2⅞" drill pipe at 7.5 bpm. After treatment, well was taking 660 bwph on vacuum.

- **Osage County, Oklahoma** (Waterflood producing well) Before treatment, this well was producing 1 bopd. Dowell fractured using Waterfrac. 8000 gallons gelled water and 16,000 pounds 20-40 mesh sand were injected. Here is production record: Immediately after treatment, 153 bopd; at 30 days, 168 bopd; after 90 days, 342 bopd; at six months, 340 bopd. After 10 months, production was still 84 bopd.

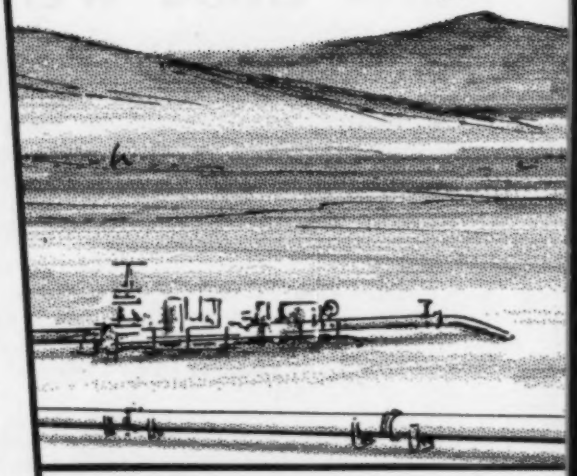
For detailed information — or for prompt service — dial Dowell. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, France, Germany and the Sahara area. Dowell, Tulsa 1, Oklahoma.

*DOWELL TRADEMARK

Services for the oil industry DOWELL
DIVISION OF THE DOW CHEMICAL COMPANY



World's Largest LPG Pipe



WILLIAMS BROTHERS COMPANY SPECIFY NEW BLOWOUT-PROOF GASKETS AS FLANGE SEAL FOR MID AMERICA'S 2,200 MILE PIPE LINE.

Engineers for Mid America Pipe Line Company, had to have a flange seal to meet some of the toughest specifications in pipe line construction. They wanted the best. They wanted a gasket with maximum effectiveness,(leakage rate equivalent to welding!) easy installation, long service life, and low maintenance cost.

After exhaustive tests and investigation they chose Gask-O-Seals.

Said Williams Brothers engineers, "Primarily we had to have a seal that was blow-out proof. The controlled confinement principle used in Gask-O-Seals proved exactly what we wanted."

Several thousands of these amazing gaskets seal main line and subsidiary equipment on this 2,200 mile high pressure system — the longest and largest LPG line ever built. It runs from New Mexico and Texas, to Minnesota and Wisconsin. The line and its complexes will serve millions of customers providing low cost and better service with Propane, Butane and natural gasoline.

WHY GASK-O-SEALS ARE SO EFFECTIVE--

Gask-O-Seals are effective because of the sealing principle involved . . . controlled confinement. That means that the "rubber" mass to groove void is carefully controlled. The gland is totally confined with metal-to-metal contact of faying surfaces. The whole seal is designed and manufactured to carefully controlled tolerances. The Gask-O-Seal design allows very, very little area of attack on the seal itself by the materials being sealed.

Of course, there are many other features about the Gask-O-Seal that makes it unique as an effective, safe, sure seal. Some of them quite technical, others just common-sense reasons. The fact that they are used in so many vital apparatuses attests to their superior sealing effectiveness.

Re-Usable Gask-O-Seals Cut Maintenance Cost

When it's necessary to tear down a flange with a Gask-O-Seal in it the ease with which bolts are "broken" and nuts unscrewed is a revelation to men used to "cracking" flanges with ordinary gaskets. The reason is simple, you simply don't have to tighten bolts as tight with Gask-O-Seals . . . in fact, on construction sites for Mid-America's pipe line you never saw a "cheater!"

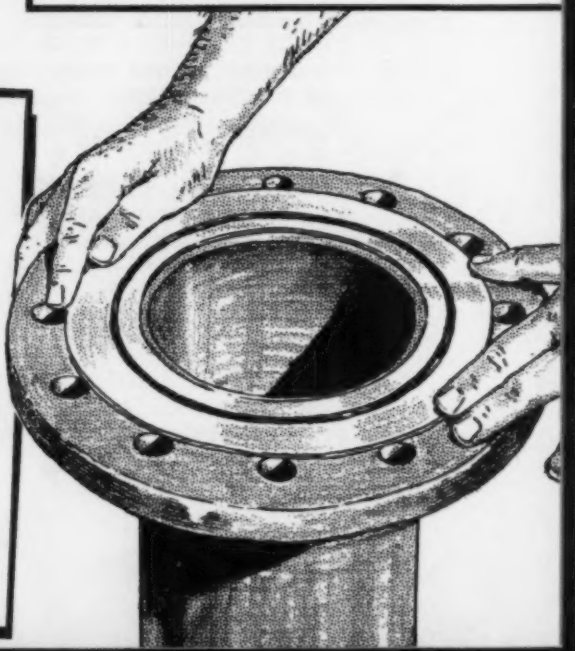
Even more amazing to pipe fitters is the fact that flange faces don't have to be cleaned and that the same gasket can actually be reinstalled!

The reduced maintenance cost mounts up to a really big saving when Gask-O-Seals are specified, whether in a pipe line, refinery, processing plant, or industrial plant.

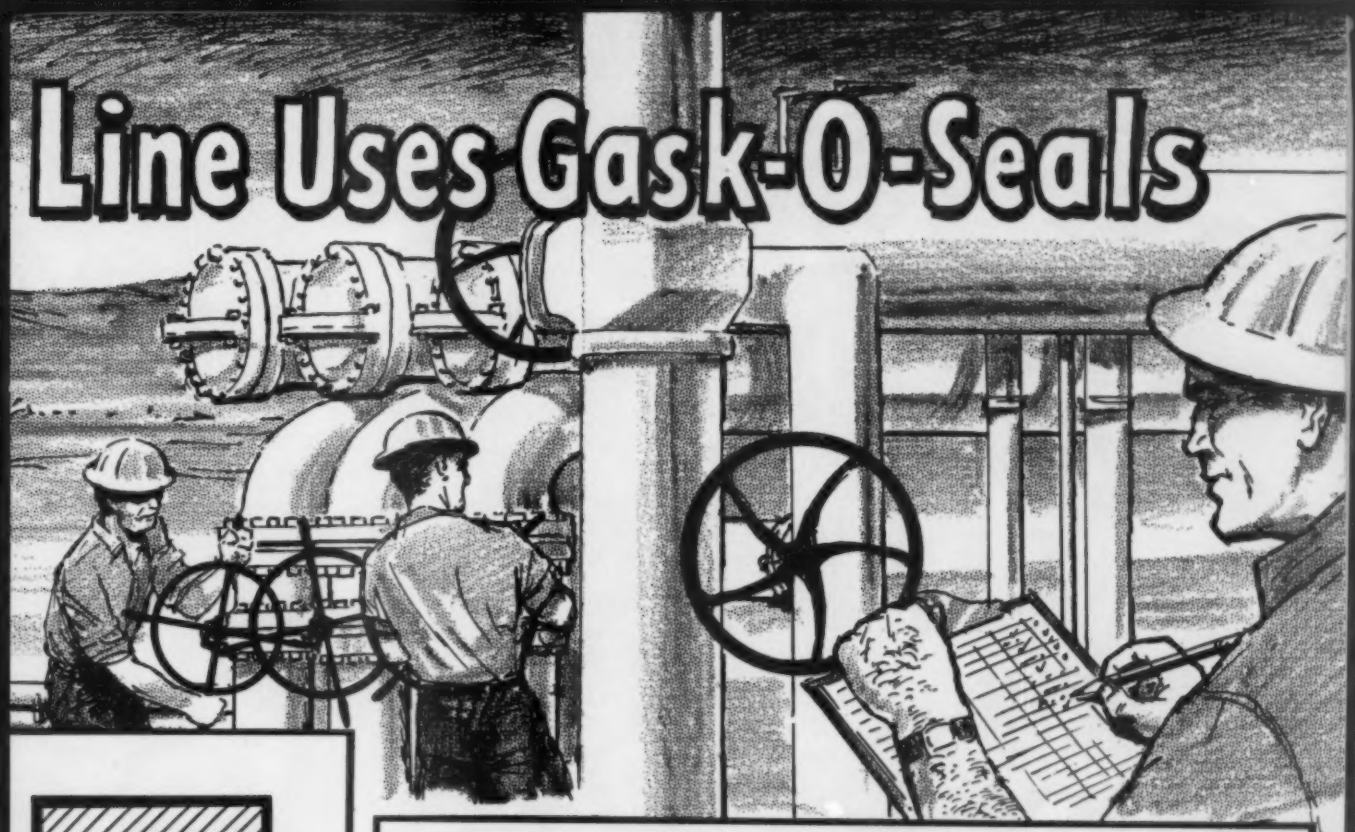
BUYERS FIND GASK-O-SEALS EASY TO ORDER—PRAISE DISTRIBUTION METHOD

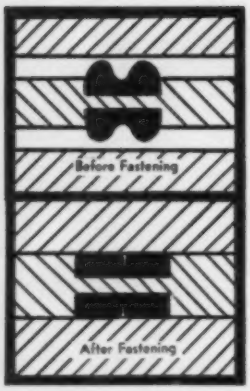
Industrial buyers find that Gask-O-Seals are readily available and easy to order with a simplified "call out" system, tieing into standard ASA flange sizes and specifications.

In addition buyers preferring local sources usually find a Parker Seal Company stocking distributor close by. More and more distributors are requesting franchises as preference for Gask-O-Seals grows. "Many of these distributors are recommended to us by purchasing men as well as engineers," says Mr. T. J. McCuistion, Vice-president in charge of sales at Parker. "Such recommendations are very much appreciated. The company will gladly consider the request of any qualified distributor for a franchise on this new product line."



Line Uses Gask-O-Seals





Underwriter's Lab Tests Gask-O-Seals, Approve For Listing

LISTED UNDER REEXAMINATION SERVICE UL UNDERWRITERS' LABORATORIES, INC. OF

To be sure that customers could have confidence in the competitive safety of Gask-O-Seals, Parker Seal Company submitted all of standard ASA flange series seals to Underwriter's Laboratories for testing. They have approved all four of the series 6400, 6420, 6430, and 6440 for listing under their re-examination code, and granted permission to use their insignia for the services covered.

HOW TO SAVE *19 MINUTES* EVERY TIME YOU "BREAK" A FLANGE!

A testing foreman on Mid-America's pipe line saw Williams Brothers men installing Gask-O-Seals in flanges at the Conway, Kansas, Terminal. He turned to the Parker Seal Co. representative standing nearby and said:

"Man, go see my boss about those gaskets. I'm saving hours and plenty of money with them. We can just put 'em in for a test, break up and move, and *re-use the same gasket, over and over again!*"

A maintenance foreman said Gask-O-Seals may save them "2 days time of two 4 man crews-with trucks, wenches and other equipment."

A survey shows it takes an average of 36 minutes to remove and install an ordinary gasket after several months use. With Gask-O-Seal it takes only 17 minutes! Here's how it breaks down:

3 minutes saved in "breaking" nuts, 3 minutes saved in parting flanges to necessary working space, 13 minutes in not having to clean and scrape flange faces — and you can install the same Gask-O-Seals you take out!

A worthwhile saving?

OVER 1,000,000 GASK-O-SEALS USED UNDER THE VERY TOUGHEST CONDITIONS BY AIRCRAFT AND MISSILES.

The sealing effectiveness and high safety factor of Gask-O-Seals were first recognized by the aircraft and missile makers to whom, safety, and genuine effectiveness of a seal is paramount.

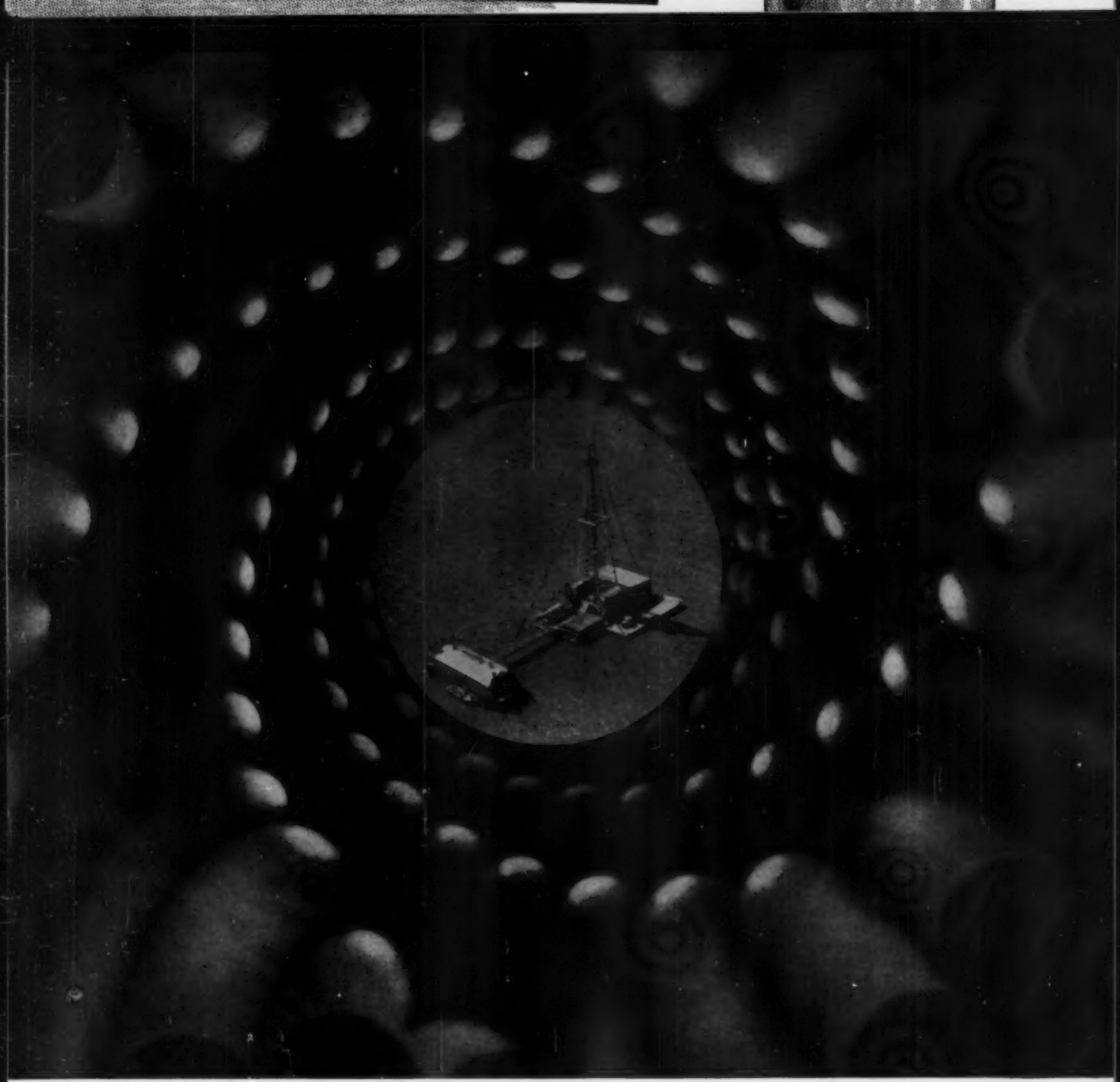
Hundreds of tests have been run on Gask-O-Seals under some of the most rugged functional and environmental specifications a seal can undergo.

Today, Gask-O-Seals—much the same as the ones used on Mid America's new pipe line—are in use on practically every military and commercial aircraft. A Gask-O-Seal, for instance, seals the escape hatch and other openings of the Mercury capsule on the "man-in-space" project.

Parker SEAL COMPANY

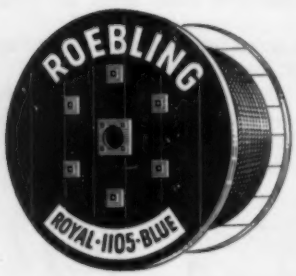
Culver City, California and Cleveland, Ohio

A DIVISION OF PARKER-HANNIFIN CORPORATION



ROEBLING ROYAL BLUE WIRE ROPE

WE PUT A LOT OF WORK INTO IT—YOU GET A LOT OF WORK OUT OF IT



This happens to be the inside view of Roebling Royal Blue — its core has been removed to show the uniformity and symmetry of the rope structure. You see how concerned we are with internal security.

We have to be. To make sure that Royal Blue will live up to the day-to-day demands made upon it. High stresses and unavoidable overloads, abrasion, fatigue, impact, crushing, sheave pressures and abusive drum-winding, to name the major ones.

Royal Blue goes through many inspections and tests—both internal and external —before reporting to work. This way we're sure that the rope we build will do what we sell it to do. These quality-control measures are your assurance that Royal Blue is made to save you money — anyway you look at it.

For details about hard-working Royal Blue, ask your wire rope distributor or write Roebling's Wire Rope Division, Trenton 2, New Jersey.

ROEBLING

Branch Offices in Principal Cities • John A. Roebling's Sons Division • The Colorado Fuel and Iron Corporation

New Series of Marsh Needle Valves in 316 STAINLESS STEEL

—Valves that take you out of your corrosion problems

Now still wider service range for the valves that have set new standards in the needle throttling field. A full line of Marsh Needle Valves are immediately available in 316 stainless steel in the new series 1936.

Identified by blue handles

Here is a valve that opens up the wide range of corrosion-resistant applications bracketed by 316 stainless. It is a valve that gives precision throttling at pressures from a few pounds through 6000 psi . . . a valve for any temperature from minus 100° F. to plus 500° F. thanks to the "Marpak" packing system making use of precision moulded Teflon.

Only Marsh experience—in both valve making and instrument making—could have produced these valves. Like other Marsh needle valves, they are available in globe and angle patterns and in panel mounted types; sizes, ⅛", ¼", ⅜", ½", ¾" and 1". The 316 stainless valves are fully described in Bulletin NV-3.

Marsh Needle Valves are also available in 416 stainless steel (identified by green handles) and in mild steel (identified by yellow handles.)

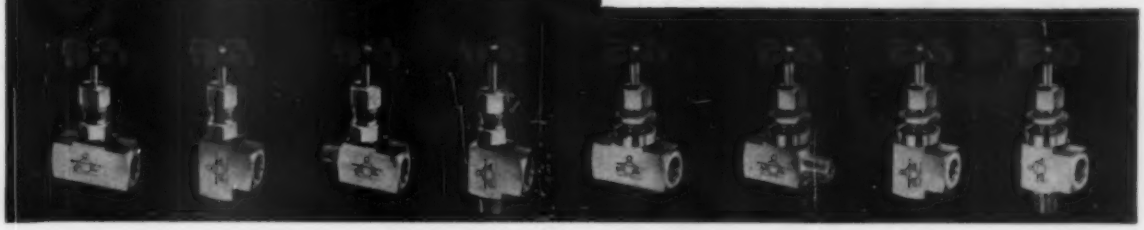
The Marsh touch—
the precision touch—in every detail

- Body and stem guide machined from 316 stainless bar stock.
- Accurately machined stem, precision ground and rolled.
- Longer inlet and outlet thread chambers insure tight make-up.
- Packing as corrosion-resistant as the valve.

MARSH *Needle Valves*

MARSH INSTRUMENT COMPANY, Dept. M, Skokie, Ill.
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co. (Canada) Ltd.
9407 103rd St., Edmonton, Alberta
Houston Branch Plant, 1121 Rothwell St.,
Dept. 15, Houston, Texas

In stock at your nearest Supply House



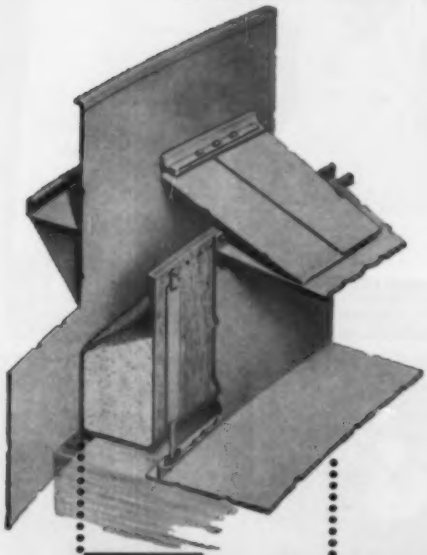
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

The oilman: makeup expert for 65,000,000 stars.

That's the number of American women who use cosmetics—beauty aids that help make a star of the lady in your life. She probably doesn't know about your part in making it possible. You—and all oilmen—help produce oil-based chemicals for face creams, lipsticks, hair sprays, bath oils, permanent wave lotions. It's a one-and-a-half-billion-dollar industry oil helps to make possible. If you ever hear someone speak out against oil—tell him you're an oilman and proud of it. And tell him why.

SHELL OIL COMPANY

FIRST solid cushion seal



When General American developed EverSeal, first solid cushion seal for floating roofs, we wanted a seal that would have these advantages:

1. Simplicity of design, no moving parts, nothing to corrode
2. Permanent, indestructible sealing qualities—no gas or liquid to leak
3. Complete protection of coated tank walls from scuffing or gouging
4. A tough, pliable envelope that would withstand abrasion; ride without damage over projections on the shell
5. Ease of repair or replacement, without taking tank out of service
6. Maximum protection against evaporation loss
7. Full protection of oxygen-sensitive stocks
8. No build-up of vapors in the seal area

EverSeal is the *first* solid cushion seal to meet *all* these requirements. It is made of trapezoidal urethane foam cushions enclosed in a tough, scuff-proof envelope of Buna "N" synthetic rubber and polyvinyl chloride plastic.

EverSeal is almost impossible to damage, always provides a safe and complete seal for every floating roof.

Write or phone your nearest General American office for complete information.

It pays to plan with General American.

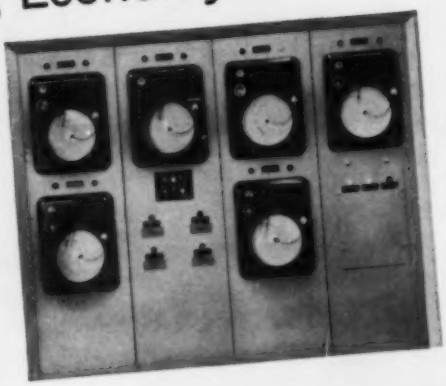
EverSeal*

*Patent Rights Reserved

by General American

American® Telemetering Equipment Means Operating Economy!

At this typical dispatching panel, one man does the work of many with American Telemetering and Telecounting equipment. At a central location, instantaneous, accurate flow and pressure readings are received from remote points and adjustments for load demands are made with remote-set controllers. Peak shaving can be performed with complete accuracy and confidence. Maximum gas sales to interruptible customers are assured.



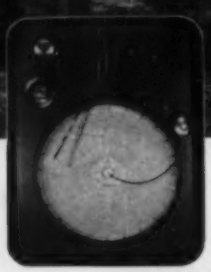
AMERICAN METER CO. EST. 1836

AMERICAN®
METER COMPANY
INCORPORATED ESTABLISHED 1836

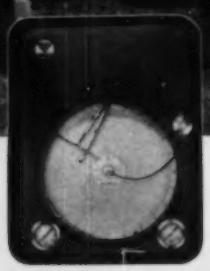
GENERAL SALES OFFICE: Philadelphia 16, Penna. • Albany • Alhambra • Atlanta Baltimore • Birmingham • Boston • Chicago • Dallas • Denver • Erie • Houston Kansas City • Los Angeles • Minneapolis • New York • Omaha • Pittsburgh • San Francisco • Seattle • Tulsa • Wynnewood

IN CANADA: Canadian Meter Company, Ltd., Milton, Ontario • Calgary • Edmonton Montreal • Regina • Vancouver

SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase, and Welded Steelcase Meters • American-Westcott Orifice Meters Instruments • Reliance Regulators • Apparatus • Valves

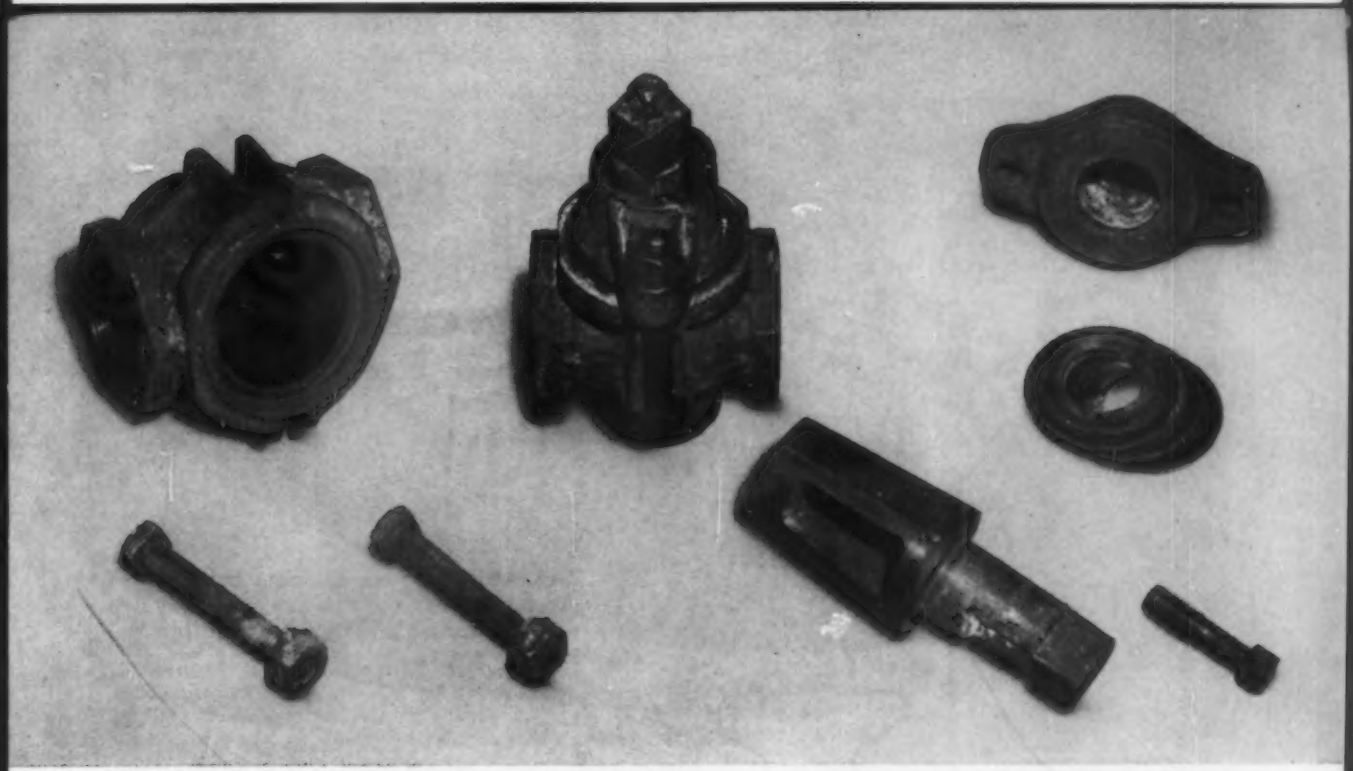


American Integrating Orifice Meters . . . Single, double and duplex-integrating models are available in a wide range of manometer types and working pressures.



American Series A-88 Controllers control flow, pressure, liquid level and other continuous process variables accurately, automatically and with a minimum of maintenance.

Whether your system is large or small, it will pay you to consult your nearest representative about the many economies American Telemetering Systems provide.



Installed on caustic lines in 1930, these Rockwell-Nordstrom lubricated plug valves needed only cleaning before installation in new plant.

THE VALVES THAT WOULDN'T RETIRE

The Rockwell-Nordstrom lubricated plug valves shown above were two of dozens installed in 1930 on caustic lines at a process plant. When the plant was torn down in 1959, the valves were still in such good condition that they're being used on the same service in the new plant.

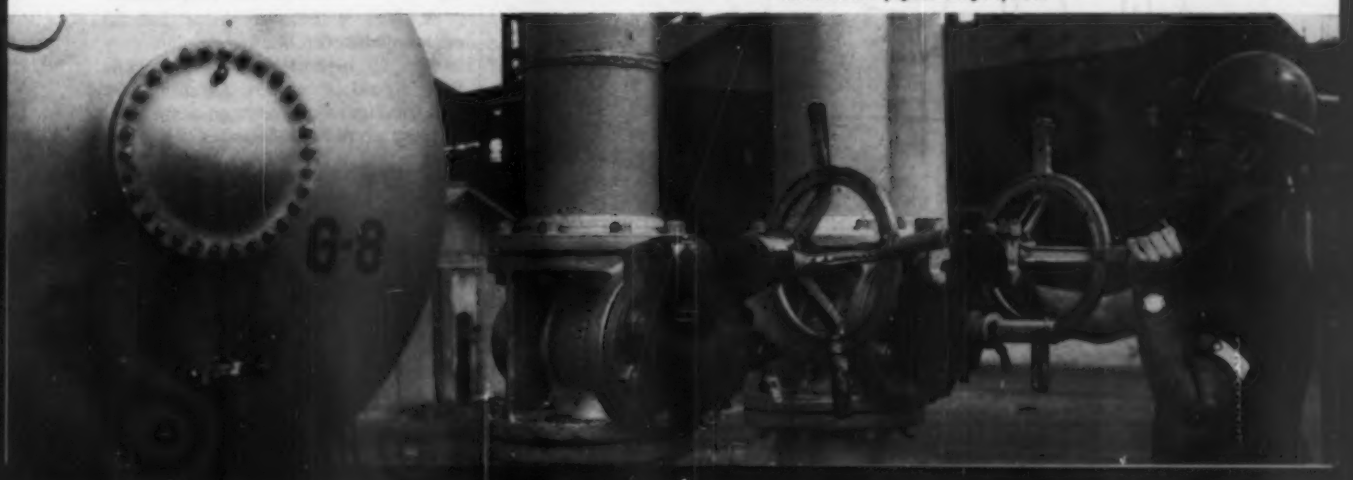
The above story is just one more example of the ruggedness of Rockwell-Nordstrom valves. Since they're sealed positively against leakage by pressurized lubricant and there are no exposed metal-to-metal seats, you get positive shut-off year after year. And, lubrication is preventive maintenance against the high cost of repairs, replacement and downtime. To get complete details on Rockwell-Nordstrom, the original and world's most complete line of lubricated plug valves, lubricants and accessories, write: *Rockwell Manufacturing Company, Pittsburgh 8, Pa.; Canadian Valve Licensee: Peacock Brothers Limited, Montreal, Quebec; Rockwell International S.A., Geneva, Switzerland.*

Lubrication Makes The Difference

ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL



These gear operated Rockwell-Nordstrom valves have given many years of trouble-free service, positive shut-off on this refinery gas storage system.

TO WHOM IT MAY

TAX ABUSES in entertainment and employee expense account reporting have continued even with the recent crackdown of the Internal Revenue Service.

So . . . . . .

The Commissioner of Internal Revenue is asking for more detailed reporting on income tax returns beginning with 1960. Employee returns will be the same, but *employers* will be required to submit more detailed reports.

Here are some questions and answers on employer reporting of employee's expenses:

Q. **Does the regulation cover all types of business organizations?**

A. Yes. The regulation applies to all employers such as corporations, partnerships, and sole proprietors. Details vary, however, with the form of organization.

Q. **What are corporations required to do?**

A. On Schedule E of Form 1120 for corporations, the section "Compensation of Officers" is being expanded. In addition to payments designated as compensation, all expense account allowances paid to or on behalf of the officers must be reported.

Q. **Does this expense reporting apply to all officers of the corporation?**

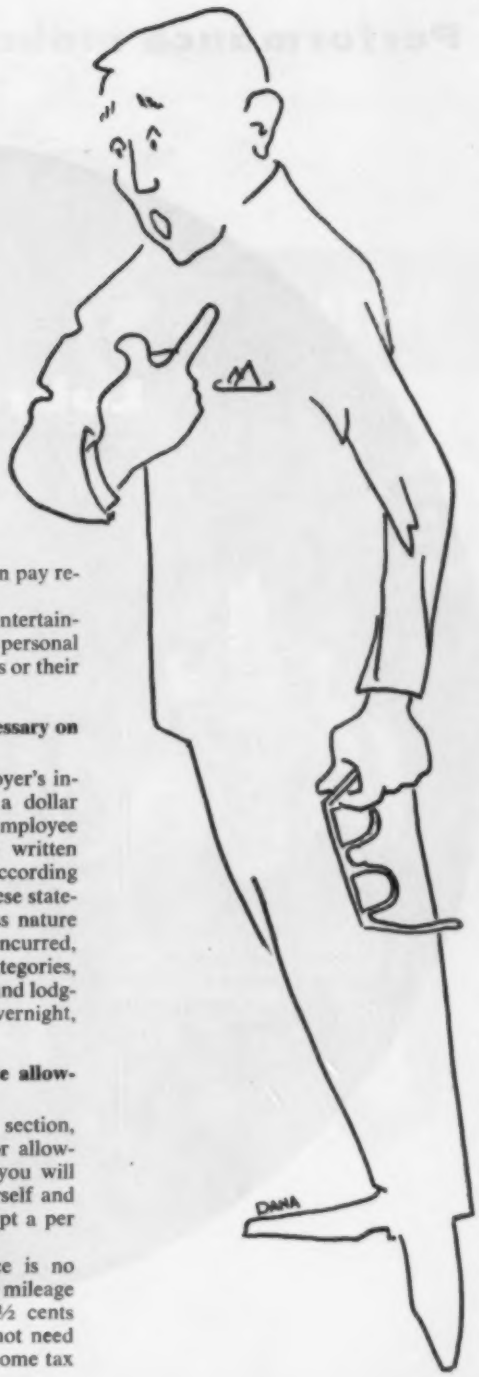
A. Yes. If there are more than 25 officers, however, it then applies only to the 25 highest paid officers. The highest paid officers are determined by the total of their compensation plus expense account allowances.

Q. **What are partnerships required to do in this new reporting procedure?**

A. Form 1065 for Partnerships will be expanded similar to the corporation form. It will require similar information to be reported about all partners. This includes limited partners of the firm.

CONCERN:

Tax Memo



Q. **What are sole proprietorships required to do under the provisions of this new reporting?**

A. Schedule C of Form 1040 for Individual Proprietorships will require similar information. This reporting covers the owner of the business and his five highest paid employees based on the total compensation plus expense account allowances.

Q. **Are there any exemptions to this rule for small firms?**

A. Yes. This detailed reporting is not required for employees who receive less than $10,000 including compensation and expense account allowances paid to or on behalf of them in one taxable year.

Q. **What does "expense account allowances" mean in this regulation?**

A. *Basically, it covers two areas of payment by the tax reporting firm:*

1. Money received as advances or reimbursements other than regular compensation.
2. Money paid by the firm for expenses incurred by or on behalf of an officer, partner, employee or owner. This includes all amounts charged through any type of credit card.

Q. **Will there be any other new information required by this new regulation?**

A. Yes. You will be required to report if you claimed a deduction for:

1. Recreation facilities including a hunting lodge, ranch or farm, fishing camp, or resort property.
2. Accommodations for customers, officers or employees including family members such as a hotel room or suite, apartment or house.
3. Convention or business meeting expenses of family members of officers or employees.
4. Vacations for officers or employees or members of their families, but not vacation pay reported on Form W-2.
5. Boat or yacht used for entertainment of customers or personal use of officers, employees or their families.

Q. **How much detail is necessary on reporting these expenses?**

A. Reporting on the employer's income tax returns will show a dollar amount for employees. The employee must be required to submit written statements to the employer, according to Revenue Ruling 59-396. These statements must show the "business nature and the amount of expenses incurred, broken down into broad categories, such as transportation, meals, and lodging while away from home overnight, and other business expenses."

Q. **Can a per diem expense allowance be used?**

A. On the new reporting section, you do not detail the basis for allowances. It could be, however, you will save time and trouble for yourself and your employees when you adopt a per diem and mileage allowance.

If your per diem allowance is no more than $15 a day and your mileage allowance is no more than 12½ cents per mile, your employees do not need to account for this on their income tax return.

Q. **Is it absolutely necessary to complete the new sections on expense accounts on the income tax return?**

A. There is no penalty for failure to complete this section. Of course, it is fairly obvious that since the Internal Revenue Service is using this to stop abuses, they will check it. Failure to complete the section will probably lead to a more thorough examination of your income tax return.

Performance makes the world of difference

POWELL Lubricated Plug VALVES

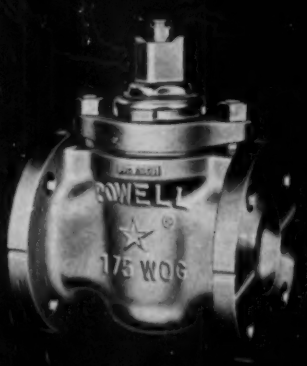


Fig. 2201—Flanged End, semi-steel Lubricated Plug Valve for 175 W.O.G. Single gland type. Wrench operated.

Fig. 2207G—Flanged End, semi-steel Lubricated Plug Valve for 200 W.O.G. Bolted Gland type. Worm gear operated.

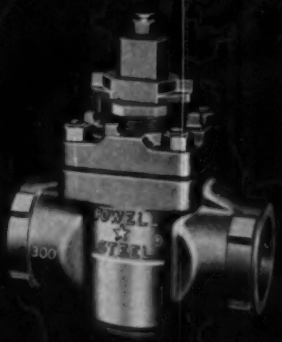


Fig. 3058—Screwed End, carbon steel Lubricated Plug Valve, ASA 300 pound. Screwed gland type, wrench operated.

Powell . . . world's largest family of valves

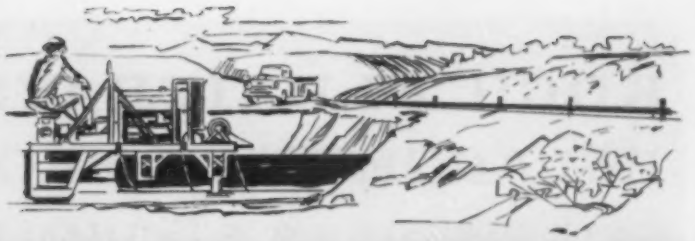
Powell Lubricated Plug Valves—a triumph of valve design and engineering—are preferred to control the flow of fluids in petroleum refineries, petro-chemical plants and oil storage facilities all over the world.

Note these Powell features: simple design (only three basic parts—body, bonnet, plug); fast opening and closing; straight streamline flow through when fully open; tapered plug for positive seating; carefully machined surfaces of plug and body are unexposed to and protected against the action of the fluid being handled when valve is open.

These valves are available in sizes from ½" through 16"; semi-steel, carbon steel, and, on special order, in other alloys. Consult your nearest Powell valve distributor, or write to us for the facts and illustrated literature.

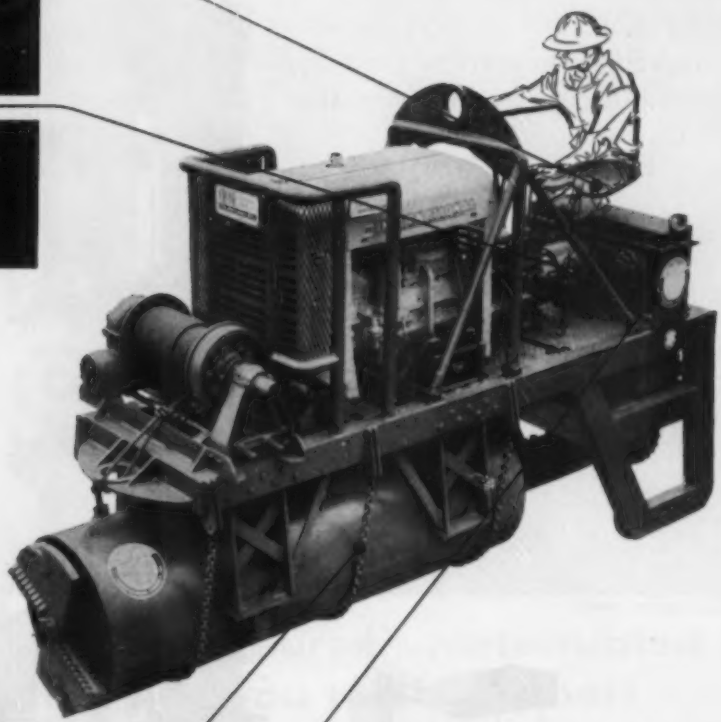
THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO

CROSE



NEW ROAD BORING MACHINE

FIELD-TESTED
TOP PERFORMANCE



The new Crose Road Boring Machine provides the fastest, simplest, most economical way for boring crossings and installing casings up to and including 42" in diameter. Heavy duty torque converter and reverse-o-matic transmission deliver full, constant speed and smooth power flow . . . let you switch auger from forward to reverse without engine slowdown . . . no gear shifting.

The smaller Model RBA Crose Road Boring Machine is still available for casing up to 24".

WRITE CROSE TODAY FOR COMPLETE INFORMATION

Crose perrault
EQUIPMENT CORP.

2765 Dawson Road • Phone WEbster 6-2171 • Tulsa, Oklahoma • BRANCH OFFICES: Houston, Texas • Elizabeth, New Jersey • IN CANADA: Edmonton, Alberta • Toronto, Ontario • EXPORT OFFICE: New York, N. Y.

KOCH FLEXITRAYS—USED 100% IN LARGEST U. S. PROPYLENE PLANT

SUN OIL COMPANY'S $2,000,000 PROPYLENE PLANT – recently placed in successful operation at Sun's huge Marcus Hook, Pennsylvania, refinery – has a potential capacity of 120,000,000 pounds of high-purity propylene per year. Reputedly the largest operation of its kind in the United States, designed to produce the high-purity propylene required by manufacturers of polypropylene – Sun's new plant is currently producing a material with 99.9% purity from refinery gas streams. KOCH FLEXITRAYS HELP MAINTAIN THAT PURITY! Type "F" Koch Flexitrays—140 in all – were specified 100% in the two distillation towers that comprise the major equipment in the new plant. Considered the most dependable and economical device yet developed for distillation absorption and stripping, Koch Flexitrays often save refineries and chemical plants 20 to 40% on total cost of completed installations! For YOUR next tower – investigate Koch Flexitray before you specify! The extreme flexibility of this low-cost fractionating tray has led to its use in more than 1500 installations.

See our catalog in "Refinery Catalog" – or contact your nearest Koch representative.

Butte, Montana, G. M. Wallace & Co., P. O. Box 208
Denver, Colorado, G. M. Wallace & Co., 324 Denham Bldg.
El Paso, Texas, G. M. Wallace & Co., 511 Electric Bldg.
Houston, Texas, Alpha Engineering Co., P. O. Box 12371
Kansas City 13, Missouri, Sample Brothers, P. O. Box 7061
New York 17, N. Y., F. J. McConnell Co., 60 E. 42nd St.
Oakland, Calif., Engineered Process Equip. Co., 600 16th St.
Park Ridge, Illinois, M. B. Fisher, 1521 Courtland Ave.
Pasadena, Calif., Engineered Process Equip. Co., 774 E. Green St.
Pittsburgh 19, Penn., D. D. Foster Co., 2210 Koppers Bldg.
Salt Lake City, Utah, G. M. Wallace & Co., Continental Bank Bldg.
Charleston, W. Va., D. D. Foster Co. 411 "D" Street
St. Louis 17, Mo., Sample Brothers, 2010 Big Bend Blvd.
Tulsa, Oklahoma, Myers-Aubrey Co., P. O. Box 5436
Montreal, Canada, Robert Muddiman Co., Ltd., 739 Mountain St.
Toronto, Canada, Robert Muddiman Co., Ltd., 518 St. Claire Ave. E.
London, W.1, England, L. M. Griffin, 6 Curzon Place
European Fabrication Available!

KOCH
ENGINEERING COMPANY, INC.
321 West Douglas, Ave., Wichita 2, Kansas
"Pioneers of Better Trays"

New Collins DC system insures uninterrupted communication...when you need it most!

Now... security against even momentary outages during power-disrupting storms. Collins' dc-powered Microwave and Carrier Systems operate directly from float-charged batteries — eliminating rotating machinery. The results: improved reliability, reduced power drain, lower maintenance, decreased noise and elimination of standby generators. Several voltage combinations are available, enabling you to select the one that best integrates with your existing plant. For technical literature, write Collins Radio Company, Texas Division Sales, 1930 Hi-Line Drive, Dallas 7, Texas.

COLLINS MICROWAVE AND CARRIER

COLLINS RADIO COMPANY • DALLAS, TEXAS • CEDAR RAPIDS, IOWA • BURBANK, CALIFORNIA

SOMASTIC®

Low-Cost Permanent Pipeline Protection

This is Somastic. It has high dielectric resistance and is moisture proof. It has tensile strength to meet severe soil stresses and depression forces. It has outstanding resistance to corrosive soils. Somastic is without question the finest pipeline protection available today.

Somastic provides lowest cost protection in both difficult and normal exposures because it gives virtually permanent protection.

Write for data giving complete facts on the advantages of Somastic.

PIPE LININGS Inc.

Subsidiary of American Pipe and Construction Co.

2414 East 223rd Street, Wilmington, California
P.O. Box 457 • Phones: SPruce 5-3273 — TErminal 5-8201
Rail Address, Pacific Electric, Watson, California

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PETROLEUM POWERS WESTERN EUROPE'S ECONOMIC BOOM

ERNESTINE ADAMS, *Management Editor*

To the casual observer, the petroleum industry in Western Europe is a tangled complex where politics and government interests play a significant role. And yet, trade barriers, astronomical taxes, red tape and political intrigue could not contain an economic boom never before witnessed by those who play a predominant role in this industrial expansion.

How does the petroleum industry, regardless of boundaries or of ownership, function in this bewildering complex? What are the economic factors at work? What is going on so far as petroleum is concerned?

Miss Ernestine Adams, a veteran oil writer of more than two decades, was past the midpoint of an extended tour of the oil capitols of Western Europe when this issue went to press. Here's her first report of many to come covering perhaps the broadest aspect of her observations. If you're an oil man and have travelled in Europe . . . or, should you go to Europe . . . you will find her analysis of extreme interest . . . and, perhaps, a big aid in better understanding the oil business there.

WE HEAR ABOUT a third force on the political scene to cushion the conflict of the big powers. There's already a third force on the economic scene that races ahead of both the United States and Russia. To some extent it uses both capitalist and communist goods and ideas and experience. But the core of its dynamism is the determination to get ahead, to collect with minds and skills a standard of living that is second to none.

This is Western Europe today — a third force moving faster than Russia, whose claims are fluid and seldom reduced to standard measurement, and faster than the United States, which seems to have been in a secret recession despite a multitude of standard statistics.

Western Europe and the United Kingdom are in a delayed post-war boom. It was delayed because many areas were a shambles after the war. Business was disintegrated. Royal Dutch/Shell, for instance, lost one-third of its staff by death or disability. It took time to get back to essential routine. It took money — a lot of it — and trained manpower to reach a normal state. It takes time for hope and ambition to rise again. Many executives in the French oil industry — a good example — are from 35 to 40 years old. They began after the war and reached management positions early.

Oil's Role

It is hard to find anyone who will estimate the part played by oil and gas in this recent economic boom of Western Europe. You can understand the reticence displayed when you have an idea of the peculiar situation resulting from oversupply of oil and sometimes bludgeoning competition. International marketers are fortunate if they come out even in West Europe. Some sell at less than cost. The cost includes posted price of crude in the Middle East. This is where international companies must look for any profit. The producers must have markets and Western Europe is a huge one — 250 million people counting United Kingdom — and living standards are rising more rapidly than anywhere in the world.

Refining has little profit margin. The president of one European company thought a new method should be developed with refiners charging a set fee for services. He was familiar enough with independent refining companies in the United States and suggested they, too, would be better off on a fee basis for service. It sounded a little like American washaterias, but they seem to make a profit and that's the main reason refiners refine.

There's a shadow dance going on in the Middle East on posted prices. Some companies there want to reduce crude prices which they feel are too artificial. But, the rulers frown on any drop and the U. S. affiliates probably would, too. So would United States independents. The sum of it is that refiners and marketers work for nothing to pump Middle East oil into the West European economy.

Don't think consumers get products wholesale. The governments step in. Gasoline in Belgium is approximately 62 cents a gallon. The government gets 41 cents and they expect to raise the tax. When asked if the industry protested, a Belgium oilman said, "At one time we posted prices and tax at the service station until the government said, 'Don't be rude' so now no one knows about the tax." He added, "You go in and say 'Fill it up' or you turn out your pockets and say 'Give me 200 francs of gas'."

In France, gasoline tank wagon price is 17 francs/liter (1 liter = 0.2642 gal), tax is 75 francs/liter and retail premium price 104 francs/liter (1 franc = 2.04 cents). Outside of Italy this is the cheapest tank wagon price in West Europe and the highest pump price.

Regardless of tax, which is much less for electrical plants and other industries, West Europe is benefiting. Its economy is pushed along by cheap oil products. What percentage of its extraordinary boom is due to this factor would be a difficult — if not impossible task — to estimate. From the other side, this economic heyday would be difficult — if not impossible — without the cheap, reliable petroleum energy that flows here.

Forced Sales

Two main forces contribute to the abundance of petroleum energy: (1) the unexpectedly large success of finding oil resources in widespread areas and the political pressures that keep supply higher than demand; and (2) the competitive (and sometimes political) pressures that have forced over capacity of refining and transportation.

Before World War II, distribution in West Europe was mostly in the hands of private international oil companies. The success of "independents" in topping new reserves (in Venezuela first) began a flow of oil without traditional markets, and crude prices eroded. Then came the national companies — RAP and BRP in France and ENI in Italy — with government funds and government powers. And last, but important, Russia began imports with cut prices for crude and products.

Some European oil men believe Russia's exports are more for economic than for political reasons. The fact is pointed out in Belgium that when fuel oil prices fell, so did Russian imports. Oil is one of the few items Russia has to sell that will bring in the exchange it needs for other goods. Sometimes it is used strictly as barter. The Soviet wants many things it can buy in West Europe. It has few things, few goods to sell that West Europe is interested in. Oil takes the place of exchange.

Now, independent marketers have emerged. And, in France, for instance, they have 13% of the market. They buy products at discount from Russians and from oversupply of local refineries.

Other Energies

There are two other energy competitors of oil products — both formidable. One is coal, the traditional backbone of European energy supply. About two years ago, fuel oil became cheaper than coal and now coal markets are on the decrease. But West Germany, United Kingdom, Belgium and France have large coal resources and large mining labor groups.

Germany met the situation with a duty on fuel oil but the action had little effect on the rise of consumption. One oil economist thought this was because of low price Soviet fuel oil imports, which permeated the market. Governments are forcing closure of marginal mines and retaining miners for other jobs. This is not so difficult in European areas where labor is scarce. One country has less than 1% unemployed.

Long-term contracts for U. S. coal (cheaper usually than European coal) were written off, with government subsidy, and a tax was laid on coal imports.

The young upstart — natural gas — is a growing competitor and could become as important as in the United States. ENI in Italy and Gaz de France have made spectacular inroads on the fuel market. **In both countries gas is a nationalized industry.**

In France, natural gas comes almost entirely from Lacq, where unique production and processing problems had to be solved to use the hydrogen sulfate-base gas from the deep, high-pressure reservoir. But this year 16 million cu meters (565,000 Mcf) are produced and distributed and, after present expansion 20 million cu meters (706,280 Mcf) can be treated. Two of the 33 wells are below 15,000 ft. The field is produced by SNPA.

At this time the General Inspector of Gaz de France, M. Robert, is in the United States studying legalities of gas exports into other nations.

Another new source of gas is French Sahara's Hassi R'Mel which now has an estimated 1 billion cubic meters (35.314 billion cu ft) in reserve. The line to the North African coast is operating and there are four possible means of transporting the gas to Europe.

First is a projected methane plant at Alzena to liquefy the gas at low temperature (Constock process), and ship to United Kingdom and other possible markets.

Also, three pipe line proposals to cross the Mediterranean are being studied: one by Tangiers to Gibraltar where depths are about 200 meters (656 ft) and currents are not strong; next from Mostaganem, near Alger, to Cartagena where the Mediterranean is some 2000 meters (6,562 ft) deep, and third to Sicily and Italy.

Gaz de France is now testing small diameter feeder pipe in the middle route and if tests go well, as they appear to be doing, this looks most promising.

What Feeds Demand

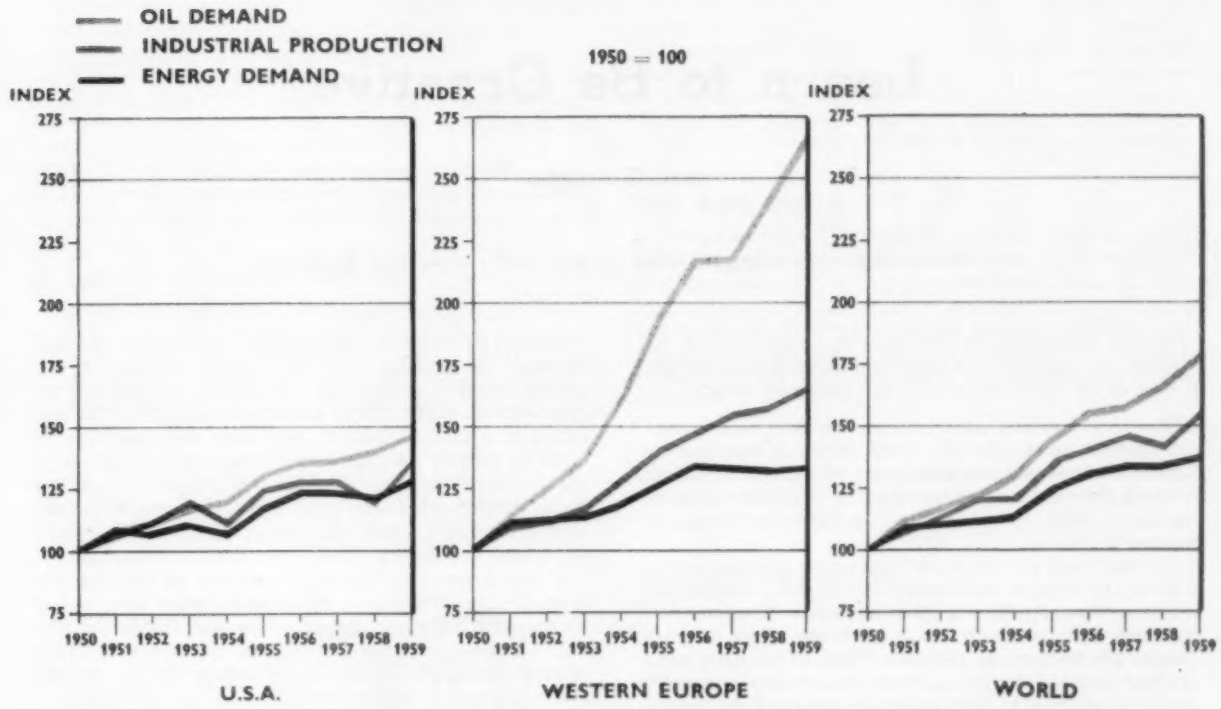
Why the startling consumption increases in West Europe? A British oilman gave these reasons for the United Kingdom and most of them apply in European countries.

1. Oil for home heating has broken through to middle income group because of rise in standard of living.
2. Dieselization of railroads, which is nearing completion in United Kingdom; is making progress in other countries.
3. At a time when there was a coal shortage, electrical construction began which was designed for fuel oil. These are coming into use now when coal is in surplus.
4. Increase in automobiles — also due to rise in living standards.
5. In many industries which use delicate processes, uniformity and quality of fuel is important. Quality of coal has fallen off because best mines have been worked and because mechanized mining is not selective.
6. More gas is being processed from oil.
7. Chemical industry stock is in growing demand.

These are the important factors that have pushed European oil demand to some 15% increase in the first half of 1960, and they will hold for some years to come. Some French oil economists say for 10 years, but France has been slower to substitute oil for coal in its economy. Others see an annual increase of about 7% for the long-term.

Much of this prediction is based on industrial growth expected from the breaking down of trade barriers in the two communities — the EEC, European Economic Community, and the FTA, Free Trade Area. Perhaps 7% increase is not impossible for several years but, as we have seen in the United States, conversion to an oil economy

INDICES OF INDUSTRIAL PRODUCTION, ENERGY & OIL DEMAND 1950–1959



— courtesy "Statistical Review of the World Oil Industry," The British Petroleum Company, Ltd., London

gives great impetus to growth in demand, which slows when that phase is over. Natural gas will also take a greater share of the market in West Europe as it has in the United States.

Business Philosophy

One question we tackled that's often asked: "How do U. S. oil companies get along in this expanding economy?" The international organizations established in pre-war times are now largely managed by nationals. Late-comers find it expedient—if not absolutely demanded—to form alliances with national companies. Results are almost entirely for the future.

Contractors and engineering companies must work within a frame of government regulations and standards different from those in the United States.

The various governments are eager to push industry within their national bounds. They support this goal with financial aid, helping to arrange loans from banks in their nations at reasonable interest rates. Tax allowances are provided. From about 70 to 90% of the whole project cost can be insured with these governments against non-payment in foreign countries. Premiums for this vary with political stability of the nation in which construction will be done. Mexico has a low rate, for instance.

U. S. contractors are sometimes understandably irritated by the refusal of U. S. government to provide any aid. They receive more sympathetic treatment from European governments than from ours, especially when they have subsidiaries in Europe. Some of the projects are using "no-strings" funds from the United States and our government offers no means by which its consulting and contracting firms can gain the assistance given freely by European governments intent on expanding national industries.

Said one contractor, "We're asked to develop business overseas, but bona fide U. S. companies are doing poorly. We have to become a European company, even a Japanese company to get contracts. Governments here are doing their countries some good: their bankers get interest on loans, their equipment manufacturers sell more goods, the governments collect taxes on increased business."

An engineering consultant with U. S. connections pointed out another business hazard in this changing business world. "Many projects now are proposed by new nations or developing areas (the term "developing" has taken the place of "undeveloped") and the business goes to the company that can arrange the best financing. Our management has to know the answers on exchange and money markets."

Engineers are scarce but quality is high. They are accustomed to making estimates in several measurements and in several languages. U. S. managements, often using English only, have double work in dealing with items that involve large sums because of the variations in standards and the language.

Competition is tough here, too. We were told there were 16 bidders on the Marsailles to Strausburg pipeline, that is being designed and will probably begin construction about mid-1961.

With all the difficulties—and there are many—the boom goes on. A large number of oil companies have new affiliates in Europe. Supply and service companies have achieved enough success to keep them encouraged.

Final appraisal can only come when demand here levels off and will depend on how much annual increases are reduced. ★ ★ ★

HOW TO BE A MANAGER

Learn to Be Creative

Jack C. Vaughn

"What man can imagine, that he can do" — Arthur Brisbane

"Since all activity begins with an idea, creativeness is the fundamental requisite of a successful business manager and is vital to the preservation of a free enterprise society."

ONE DAY not long ago, an executive in a mid-western city mulled over, for the tenth time, a problem in human relations that was threatening to disrupt the smooth working technical staff he had spent several years developing into a team. It was a tough problem, centering on personality clashes.

He had tried all the stock approaches. He had talked individually with the three staff members most prominently involved. He had talked to the other, lesser executives who had also been indirectly drawn into the affair. He had juggled job descriptions and shifted lines of authority in an attempt to clear the air. All had proved only temporary pieces of patchwork. The underlying causes of the tension were left untouched.

Something clearly had to be done immediately or he would have to ask for resignations from one, or two, or possibly all three of the men involved. And with their departure would go the fruits of his own patient years of "building."

Finally, he hit upon a bizarre idea — unusual to be sure, but then, the situation itself was unusual. At bedrock, the trouble centered around that old bugaboo — vanity — the most elusive of all faults to corral and tame. Since his best efforts at a direct approach had failed, the executive hit upon an indirect one: he simply wrote out in longhand a short fable, about three very competent but hypersensitive house painters who, with great skill and precision, painted themselves into a corner and then got embroiled in arguing about who was the one most responsible for their plight.

It was a very brief piece of satire but its meaning was unmistakable. Distributing this hand-scrawled little yarn to his troubled assistants, the executive soon confirmed that the sharp edge of mirthful satire accomplished what all the directness and job-juggling had failed to do — it brought the young men to their senses.

This example of effective management is certainly not an epic one; yet it constitutes one more small example of a great truth that has long characterized American free enterprise: the successful managers are creative men, and the more creative, the more successful.

Since all activity begins with an idea, creativeness is the fundamental requisite of a successful manager.

Jack C. Vaughn *is president, director and co-owner (with brother Grady H. Vaughn, Jr.) of Vaughn Petroleum, Inc., Dallas, Texas. Formerly Spartan Drilling Company, this firm has interests spread over 17 states, Alaska, Cuba, and the Sahara Desert. Jack Vaughn graduated from the University of Texas in 1947, majoring in personnel administration. He and his brother formed Spartan Drilling Company when he was still at Texas University.*

In addition to his oil interests he is the principal stockholder, president, director and founder of the Spartan National Life Insurance Company. He is an executive of other insurance firms, is in partnership with his brother in a land and cattle business and handles added interests in his personal company, Jack C. Vaughn Enterprises, Inc.

He gets a kick out of pioneering in new fields — he organized Continental Copters, Inc., Texas' first commercial helicopter company and he was an original director and investor in Sabre Uranium, the first uranium company cleared in Texas by the Securities Exchange Commission. He also introduced the "Pigeon Hole" auto parking system to Dallas and the Southwest. He has numerous real estate holdings, TV-Radio interests and banking enterprises. At only 34 years, Jack Vaughn is now the Southwest Area vice president of the Young Presidents' Organization.

WHAT IS CREATIVITY?

The quality of being creative is not, of course, something that can be put on like a hat and then doffed at the end of the day. Basically, as Henry Ford said, it is "an attitude" — a willingness to try something, even though it has never been done before, just for the good and simple reason that it seems like a well-thought-out idea. It is a quality —

Try a new idea.

though often undefined — that many top executives look for in filling key managerial slots.

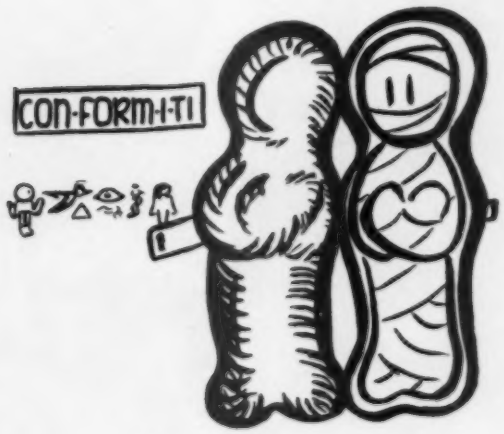
Broadly defined, management itself is nothing more than a day-to-day creative job of finding solutions to problems. The businessman with no vision, no ability to conceive of new goals and new methods of attaining those goals — in short a businessman with no creative insight — has little prospect of developing genuine managerial skill. And yet, the seeds of creative ability reside in every man. Developing this universal urge — in himself and in his subordinates — is thus one of a manager's foremost tasks.

Too many of us actually welcome means of stifling our creative instincts, and use the excuse that the business world demands conformity and creativity is for the artists.

TO CREATE, YOU NEED FREEDOM

The primary reason free competitive enterprise is more productive than the planned society of socialism is that in a free enterprise system men remain free to create. In a socialist society, on the other hand, conformity is at a premium, and "building a better mousetrap" offers no assurance of success.

The oil producing industry, perhaps more than any other, exemplifies the free enterprise system in that success remains possible for the shoestring operator with an idea and the courage to risk his all to back it. America — and more particularly Texas — I think would have been an oil



Not much room in a mold.

have-not area long ago if drilling activities had been directed from a central source, or even by top management of a few large companies.

Wherever men remain free to pursue individual economic gains — in other words, to exercise the creativeness involved in meeting a potential consumer need — that society has prospered. Where opportunity for creative thinking has been denied or thwarted, shortages tend to develop, and freedom disappears not only within the economic but within the political system.

The best way to assure the preservation of a free society is to encourage the development of creative managers in the business world. If creativeness is absent in business, it is not likely to survive among the arts.

When J. P. Morgan put together the historic U. S. Steel amalgamation over a half century ago, he was performing far more the role of the pioneering creator than he was the role of a staid banker. Similarly, when John D. Rockefeller first perceived that the path to greatness in the petroleum business lay in capturing the refining segment of the industry, he made a creative deduction that other men could have made, but didn't.

Henry Ford revolutionized American business practices again and again through his brilliant perception of the changing face of America's emerging industrial society. His concepts of mass production, of "a car for everyone," and his stunning breakthrough in the field of labor relations by the simple expedient of offering the unheard of sum of $5.00 a day wages — these were measures, truly creative in their times, by which he left his competitors far behind.

YOU NEED ETHICS

Creativeness, of course, is no panacea. When not based on ethical motives, creativity can become a devilish force in a free society, as Jay Gould proved to the nation's dismay around the turn of the century. A creative financier and a master manipulator, Gould skirted through companies and boards of directors with a fleetness of foot that left everyone reeling. Today's business world is not without such entrepreneurs.

Such men share with the nation's more responsible business leaders the breadth of vision, the grasp of changing conditions, the unwillingness to accept the status-quo that has always distinguished creative leaders from complacent, unimaginative followers.

YOU NEED IMAGINATION

The range of creative potential in managers and would-be managers varies greatly of course. A man firmly wedded to the idea of "security" is not likely to cause much stir with new ideas. On the whole, creativeness is the product of individualism and, as such, is quite unlikely to be effectively developed in those who have long since laid aside their own individuality so they may pursue "security."

Those stable drones, bent on security, who come unswervingly to work every morning and plod through the day doing their assigned tasks — such persons may well perform useful service in the ranks of any company. But they will never be imaginative, inspired leaders for they lack the essential individualism that makes for the most effective managerial performance. In short, they have stifled their own potential for creativity.

The clay from which dynamic managerial ability can be molded must come from an inner drive that produces — to use Henry Ford's word again — an "attitude" of willingness to try new approaches and new methods.

It perhaps should be emphasized that this attitude must also be comprised of a hefty portion of personal courage, and faith in oneself, in order to "sell" new ideas effectively to the people who must put them into action. This is a necessary requirement for the simple reason that there is a built-in resistance to change — in people as well as in organizations. And yet modern business conditions are so fluid that the company which isn't flexible and adaptable — which doesn't have imaginative managerial leadership — is going to suffer in the competitive race.

The cow that jumped over the moon had to drop her cud of security.

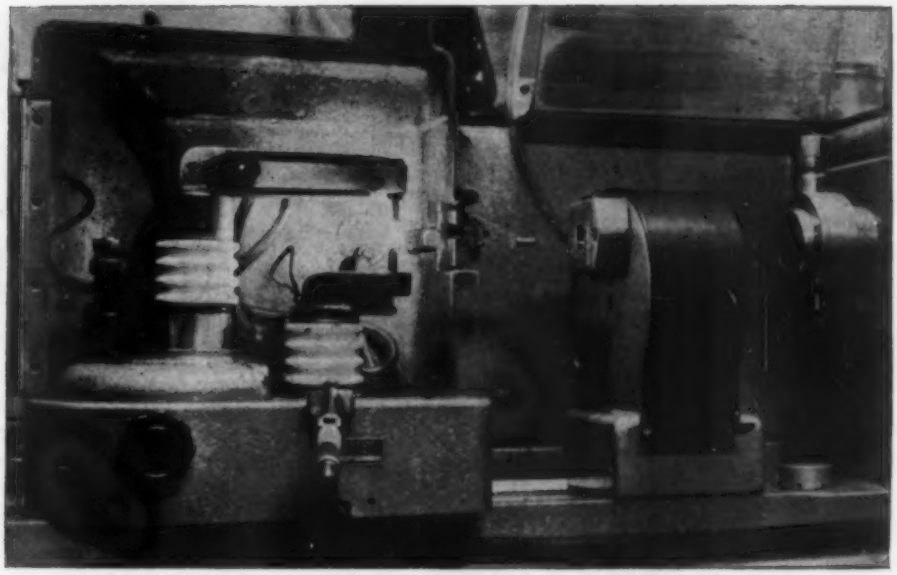
10,125 tests a day assure consistent quality in

GULF MAKES THINGS

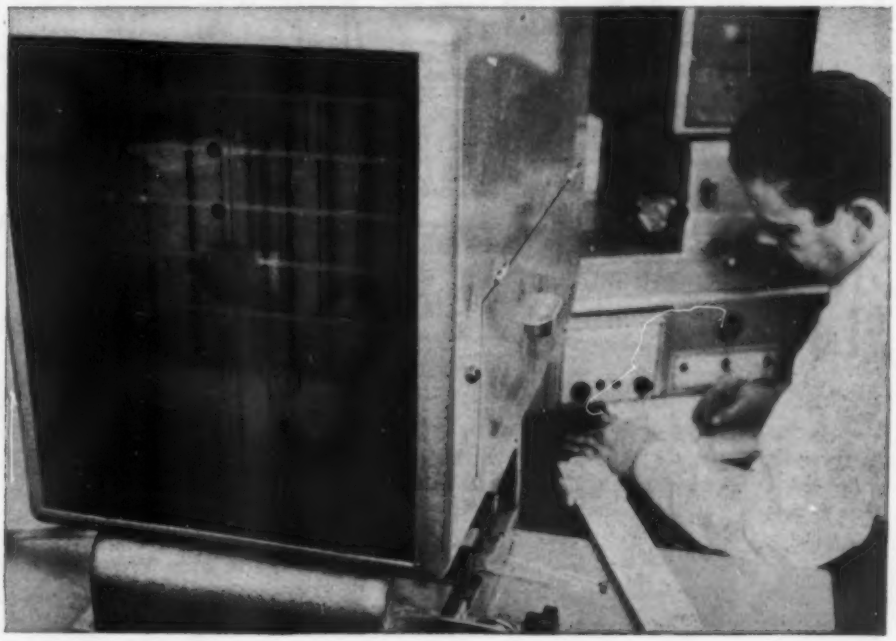
These bottles contain samples of a variety of Gulf fuels and lubricants. Each has been subjected to a series of quality control tests at Gulf laboratories. Any one of the tags shown might carry the "pedigree" of a Gulf product for a drilling rig or a pipeline pumping station.

Product purity is policed constantly at Gulf. During the refining process, samples from *every* lot of Gulf gasoline, diesel fuel, lubricating oil and grease are tested and re-tested to make sure that formulations are exact and that impurities are essentially eliminated. For ex-

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Emission Spectrograph (above) causes undesirable elements in a petroleum sample to emit their characteristic light spectrum which is photographed on a strip of film. In the Densitometer (below) the spectrum on the film is evaluated to identify the presence of metal contaminants down to less than one part per million.



every Gulf® product . . .

RUN BETTER!

ample, Gulfcrest® 44, world's leading turbine oil, is quality-controlled to limit contamination to less than one part per million.

A continuing program of quality control tests is one of the reasons we say: Gulf Makes Things Run Better!

GULF OIL CORPORATION
Department DM, Gulf Building
Houston 1, Texas

GULF®

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

YOU NEED BOLDNESS

The business world of today demands a new, and in some respects, a bolder creativity on the part of its managers. The simplicities of yesteryear have given way to complex patterns of management that today offer far stiffer tests to executives. The career of John Loudon of Royal Dutch Shell is a case in point that illustrates vividly how a really perceptive and creative manager can foresee changing conditions and act accordingly in a manner that dramatically affected his company's operations.

Years ago, as Venezuelan manager for the Shell group, Loudon was not content to do a bang-up job in the day-to-day economic operations of his company; he kept his eye on the political situation in Venezuela as well. Noting the budding nationalistic sentiment in the people, the possibility of sweeping changes in the government and the chance that expropriation might be just around the corner, Loudon changed the company's policies to accommodate the new political feeling among Venezuelans. The result was that when a new regime did come to power, its relations with Loudon and with the Shell group were on a congenial enough basis that the transition was quite serene.

By imaginatively responding to a challenge that was

Using complexities takes boldness.

unknown to American managers 25 years ago, Loudon dramatically demonstrated his talents that ultimately carried him to the top-most management reaches of the giant Shell organization.

YOU NEED ADAPTABILITY

While it is intelligent to profit by our past mistakes, it is often necessary to avoid relying too heavily on this old axiom for the simple reason that in the changing world of today's business, the circumstances that influenced last year's or last month's decisions may never again be applicable. Next month's decisions may have to be forged in a wholly new climate — brought about by a sudden hardening or softening in the money market, by sharp changes in land valuations, by tariff or import levies, by new legislation, or by any one of a score of other causes that affect day-to-day corporate life.

So, in this sense, being creative also means being adaptable. It means being able to put aside that which worked yesterday, and putting it aside in time to avoid an unexpected

Yesterday's preparations aren't always applicable today.

failure. Progressive companies can be so characterized because their managers are creative, adaptable men. On the other hand, "tired" companies which have failed to develop their full growth potential can almost always trace part or all of their failure to a management team that is satisfied with the status quo and is "going through the motions."

Executives who are afraid to make mistakes are similar to the young college graduate who is dominated by the idea of "security." Neither ever appreciated the old proverb, "nothing ventured, nothing gained."

The creators are willing to "venture." They are the true living spirit of American free enterprise.

These Are Important Questions:

1. If individualism is one of the keys to "efficiency," how can large companies, with specific corporate policies, best foster individualism?
2. Were the business geniuses of a half-century ago creative men?
3. Can their maxims be applied today?
4. How can creativity be encouraged in subordinates?
5. Can the desire for security be made an aid in developing creativeness?
6. How can "resistance to change" in an organization be overcome?

You May Want to Read —

[1]*Harwood F. Merrill, "Classics in Management," American Management Association, 1960.*

[2]*W. Lloyd Warner and Norman H. Martin, "Industrial Man," Harper & Brothers, 1959.*

[3]*Carl Heyel, "Organizing Your Job in Management," American Management Association, 1960.*

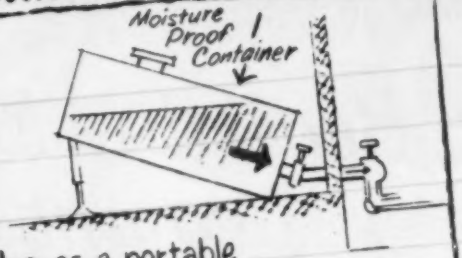
[4]*Eugene J. Benge, "How to Become a Successful Executive," Frederick Fell, Inc., 1960.*

[5]*Harwood F. Merrill and Elizabeth Marting, "Developing Executive Skills," American Management Association, 1958.*

[6]*Edward Hodnett, "The Art of Problem Solving," Harper & Brothers, 1955.*

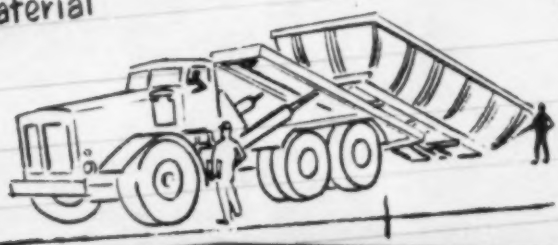
[7]*Dan H. Fenn, Jr., "Management in a Rapidly Changing Economy," McGraw-Hill, 1958.*

Materials Handling Ideas with the Dempster Dinosaur



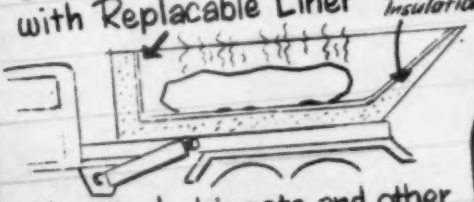
Use as a portable Hopper for temporary storage of wet or dry material

Use as a portable cable reel station - or for handling rolls of paper or steel

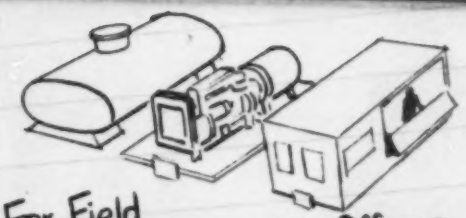


Shift heavy in-plant movements from rails to rubber with Dinosaur and 100,000 lb. capacity trucks... For slag... ingots... stone or chemicals.

Double Wall with Replacable Liner



Handle hot ingots and other materials with insulated containers.



For Field Operations Portable Offices, Tool Sheds, Generators, Fuel Tanks, Compressors etc. can be moved to the site by the Dinosaur.

DEMPSTER BROTHERS offers a New Dinosaur Brochure, Free on Request

DEMPSTER BROTHERS
Inc.
Knoxville 17, Tenn. Dept. PE 11

The DEMPSTER DINOSAUR®

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

MISSILES TO MUFFLERS

Bridge production gap for oil field manufacturer

Beaird-AMF A company on the go!

NEW PRODUCTS, SKILLS, IDEAS SPARK DRIVE

Under the guidance of a tall (6′3″) soft-spoken Texan, President John L. Tullis, Beaird is on the rebound from a low caused when the oil industry skidded into its own personal recession in 1958.

Long a major supplier of equipment (skid-mounted packaged compressors, pressure storage vessels, rail tank car tanks, steel piling, LP-Gas transports and home LP-Gas systems), Beaird has repeatedly demonstrated its ability to move swiftly in a competitive situation. Pioneering with the first packaged compressor plant in 1946, they established and dominated the market for this product despite intensive competition. Equally in the LP-Gas industry, Beaird moved, in five years, from its first LP-Gas system in 1946 to the industry leadership, with a host of products serving every phase of the market from dealer to home.

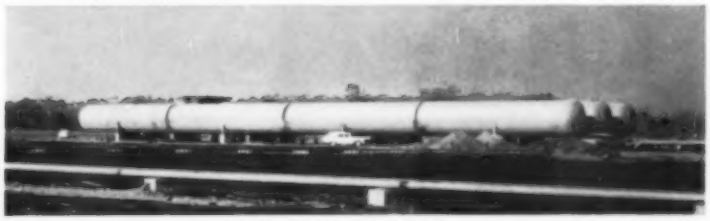
Now entering new markets with new creatively engineered products ("Belex," a self-operated condensate recovery unit for installation at wellheads and a skid-mounted complete gasoline plant composed of eight separate processing units), Beaird has received an additional boost from acquisitions and defense contracts. Maxim, the oldest name in silencers (gross sales $3,000,000 in 1959) has been acquired by AMF and assigned to Beaird to manufacture and market. The bustling shop program is also producing an $8,500,000 order for giant Atlas Missile launching components and a large order for stainless steel Titan missile fuel tanks. Beaird has targeted a stepped-up sales goal in '60 and is headed upward with a rush that may well take it far beyond its most optimistic predictions. From its people in the shops to its wide-flung dealer and sales organization, there is a firm belief that Beaird-AMF is a company on the go . . . *and getting there in a hurry!*

BEAIRD - AMF

World's Largest Fabricator of LP-Gas Systems

Long lasting enamel finish is just one of many basic improvements Beaird has brought to LP-Gas industry. To make new finish possible Beaird installed giant "assembly line" plate shot blast equipment at both Shreveport and Clinton plants. Beaird has continued to strengthen its LP-Gas market position with a vigorous dealer program that includes area stocking and long term financing.

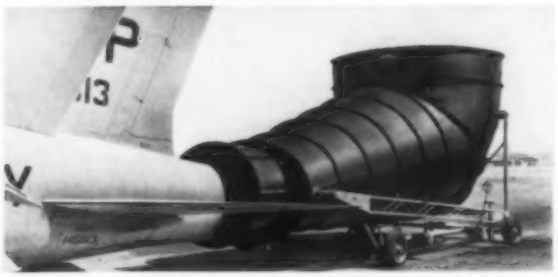
CO_2 Transport, has welded aluminum shell over four inches of insulation that surrounds the T-1 steel . . . 325 psi tank. Other specialized Beaird units are formed of stainless steel for chemical hauling. T-1 Steel Transports for LP-Gas Market lead Beaird transport sales.



World's largest LP-Gas storage vessels — capacity 5,000 bbls. each were built by Beaird for Creole Petroleum, Venezuela. One of firm's oldest and best known products, Beaird storage vessels are manufactured in a size range from 6,000 wg. to 105,000 wg. capacity for the oil, gas and petrochemical industries.

Belex Condensate Recovery unit, mounts at wellhead to extract hydrocarbons (gasoline, propanes, methanes, etc.). Fully packaged and automatic in operation, the Belex unit offers high product recovery with low installation cost.

10,000,000 Cubic Feet of Gas per Day can be handled by this Beaird Skid Mounted Gasoline Plant. Expensive field labor and installation hook-up is reduced to minimum and the plant is almost wholly salvable when moved to a new location. It was process engineered and installed by O. L. Olson Engineering, Houston, Texas.



Twenty-five ton silencer, one of the many Maxim silencers now produced by Beaird. Others include little two-pound units for home lawn mowers, sizes for heavy duty engines and special types for ships and industrial plants.

another AMF BEAIRD product

THE J. B. BEAIRD COMPANY, INC.

A subsidiary of American Machine & Foundry Company

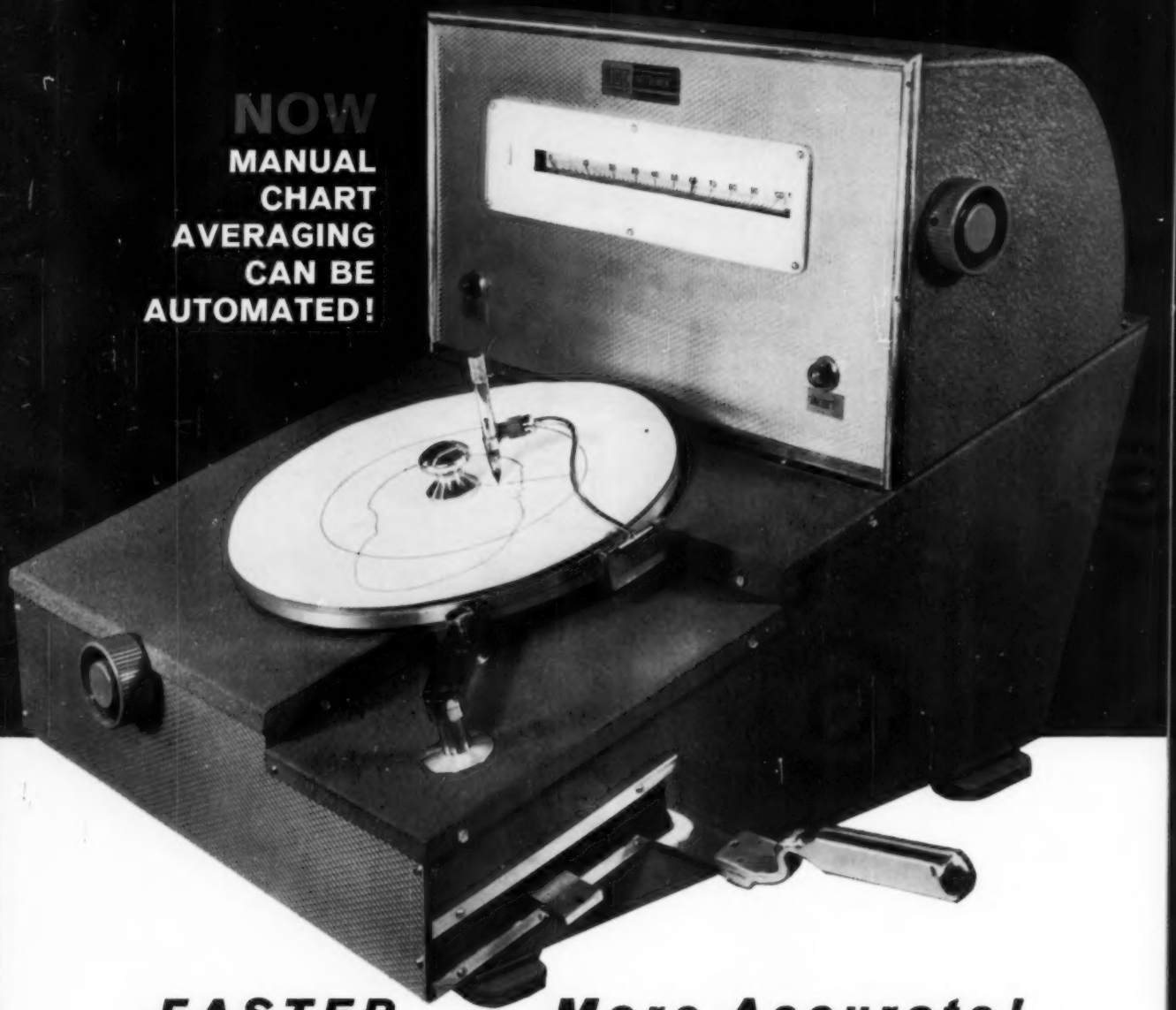
SHREVEPORT, LOUISIANA

SALES OFFICES

Shreveport, New Orleans, La. • New York, N. Y. • Tulsa, Okla.
Houston and Midland, Texas • Hartford, Conn.

BEAIRD INTERNATIONAL, INC.
SHREVEPORT, LOUISIANA

Navy Submarine has an AMF-Maxim monel and stainless steel sea water plant which demonstrates Beaird's new metal handling skills. Fabrication including welding of aluminum and magnesium for rail tank cars as well as work in other exotic metals has become a routine assignment at Beaird.



FASTER . . . More Accurate!

The UGC CHART AVERAGER continuously averages temperature, gravity or pressure charts. ONE OPERATOR in ONE OPERATION handles the job without comptometers, adding machines or the need for checking. No special operating skill is required other than a short period of instruction.

TIME SAVING—Typical time saving *per chart* is three minutes as compared with the time-consuming manual method.

ACCURACY—During a period of two months, more than 2,300 charts were manually calculated and AVERAGER figured. In every case the Averager produced correct averages as previously determined in the slower manual procedure.

RELIABILITY—In 2½ years of research and testing, and with more than a year's actual operation in the United Gas chart offices, the all-mechanical AVERAGER system has been performance-proved for minimum repairs and maintenance.

MODELS AVAILABLE— Averagers are available for practically any circular chart—temperature, pressure, specific gravity, flow-rate or other process variables.

Strip chart models are available on special order.

For further information write or phone:
UGC INSTRUMENTS
P. O. Box 1407
Shreveport, Louisiana
Phone UN 1-4531—LD81

UGC
A DIVISION OF UNITED GAS CORP.
INSTRUMENTS
CHART AVERAGER

"There is much evidence that we are on the verge of a scientific revolution that will transform our world more rapidly and completely than did the industrial revolution in the nineteenth century. This transformation will give to millions of people wider opportunities to satisfy their basic needs, and among them will surely be the need for more products derived from oil." —M. J. Rathbone, President

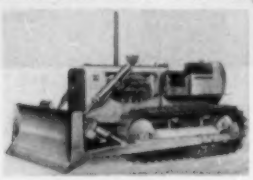
Standard Oil Company (New Jersey)

WHY GEORGE PEASE USES

D6s for SITE PREPARATION

THIS is one of 60 sites recently prepared by George W. Pease for a large oil company. The location: Osage County, Oklahoma. The job at each site: leveling an area about 85 feet x 130 feet for drilling rig and equipment and digging a slush pit 70 feet square and 5 feet deep. Depending on conditions, it took the Cat D6 Tractor with No. 6S Bulldozer from one to three days to prepare a site.

Why did George Pease choose the D6? An important reason, he'll tell you—"It stands up better than competitive machines." His is no snap judgment, for he's a veteran with 16 years' experience in the business. Ask others like him, who make their living in the same kind of tough work, and you'll hear the same verdict on the D6.



NOW THE NEW D6 SERIES B

Stacked against the previous model—or against any tractor of comparable size—the new D6B is even further out front from every angle: greater production, low-cost operation and time-saving maintenance. Some reasons why:

NEW ENGINE—A Cat D333 Diesel Engine (93 flywheel HP) delivers 25% more lugging ability. New direct-acting governor for quick fuel adjustments handles loads faster.

NEW INTEGRAL HYDRAULIC SYSTEM—Under-the-hood mounting of tank, pump and valves permits convenient routing of hydraulic lines to bulldozer or implement cylinders, frees front and rear for other equipment.

NEW OPERATOR CONVENIENCE—An all-new cockpit has coordinated controls that make the tractor operate almost as if it knew what was needed next.

NEW 8-FOOT BULLDOZER BLADE—This shorter straight blade combines productive capacity with narrow width. No highway permit is required to move machine from job to job.

And that's not all. The new D6B also features dry-type air cleaner, hydraulic track adjusters (optional), lifetime lubricated track rollers, the oil clutch and forward-reverse lever. Get the full details from your Caterpillar Dealer. Ask him to *show* you how the new D6 can step up production on your job!

Caterpillar Tractor Co., General Offices, Peoria, Illinois, U.S.A.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

MODERN HEAVY-DUTY MACHINES FOR THE HARD WORK

Meetings . . .

Nov. 14-16 — **Society of Petroleum Engineers of AIME,** Venezuelan sections, 4th annual meeting, Site unreported, Maracaibo, Venezuela.

Nov. 14-16 — **American Petroleum Institute,** annual meeting, Conrad Hilton, Palmer House and Congress hotels, Chicago, Ill.

Nov. 15-16 — **Natural Gas Pipe Line Institute,** Court House, Liberal, Kans.

Nov. 15-16 — **API,** Board of Directors meeting, Conrad Hilton Hotel, Chicago, Ill.

Nov. 16 — **API,** Executive Committee of Board of Directors, Conrad Hilton Hotel, Chicago, Ill.

Nov. 17 — **National Industrial Conference Board,** general session, Penn-Sheraton Hotel, Pittsburgh, Pa.

Nov. 18 — **Natural Gasoline Assn. of America,** Panhandle Plains regional meeting, Herring Hotel, Amarillo, Tex.

Nov. 21-22 — **Society of Petroleum Engineers of AIME,** formulation evaluation conference, Cullen Auditorium, University of Houston, Houston, Tex.

Nov. 27-Dec. 2 — **American Society of Mechanical Engineers,** annual winter meeting, Statler Hilton Hotel, New York, N. Y.

Dec. 5-7 — **American Society of Agricultural Engineers,** winter meeting, Hotel Peabody, Memphis, Tenn.

Dec. 15 — **National Industrial Conference Board,** meeting of board members, Waldorf-Astoria Hotel, New York City.

1961

Jan. 15-18 — **Pipe Line Contractors Association,** San Francisco, Calif.

Jan. 16-19 — **ISA Winter Instrument — Automation Conference and Exhibit,** Sheraton-Jefferson Hotel, St. Louis, Mo.

Jan. 19-20 — **National Industrial Conference Board,** general session, Waldorf-Astoria, New York City.

Jan. 20 — **Natural Gasoline Assn. of America,** Gulf Coast regional meeting, The Robert Driscoll Hotel, Corpus Christi, Texas.

Feb. 5-10 — **ASTM,** Committee D-2 meeting, Benjamin Franklin Hotel, Pa.

Feb. 16 — **National Industrial Conference Board,** meeting of board members, Waldorf-Astoria Hotel, New York City.

Feb. 24 — **Natural Gasoline Assn. of America,** South Louisiana regional meeting, Lafayette Petroleum Club, Lafayette, La.

Feb. 26-Mar. 2 — **Society of Petroleum Engineers of AIME,** annual meeting, Chase and Park Plaza Hotels, St. Louis, Mo.

Mar. 8-10 — **API Division of Production,** Southern District meeting, Captain Shreve and Washington-Youree Hotels, Shreveport, La.

Mar. 13-17 — **National Assn. of Corrosion Engineers,** annual meeting and corrosion show, Hotel Statler, Buffalo, N. Y.

Mar. 15-17 — **Natural Gasoline Assn. of America,** 40th annual convention, Baker Hotel, Dallas, Texas.

Mar. 22-24 — **API Division of Production,** Southwestern District meeting, Cole Hotel, Albuquerque, N. M.

Mar. 23 — **National Industrial Conference Board,** general session, Shamrock-Hilton Hotel, Houston, Texas.

Mar. 27-29 — **Midwest Gas Assn.,** annual meeting and convention, Sheraton-Fontenelle Hotel, Omaha, Neb.

Mar. 27-31 — **ISA,** 3rd Symposium on Temperature, Veterans Memorial Auditorium, Columbus, Ohio.

Apr. 5-7 — **API Division of Production,** Mid-Continent District meeting, Mayo Hotel, Tulsa, Okla.

Apr. 5-7 — **Kansas Oil Men's Assn., Management Institute,** University of Kansas, Lawrence, Kan.

VICTAULIC®

The Time-and Job-Proven Method of Reducing Piping Costs

NEW RIGID COUPLING STYLE 88

For Tank Batteries, LACT, Field Headers, Water Flood Manifolds and other Oil Field Piping

- Non-sag
- Non-flex
- Non-swivel

NEW 77Y COUPLING

FOR CEMENT LINED PIPE
With New Y-Insert Gasket

- Eliminates cavity between pipe ends
- Protects bare end of pipe from line fluid
- Long-life service in water flood and disposal systems

CUT COSTS WITH OVER 1100 VICTAULIC ITEMS FOR BETTER AND EASIER PIPING

For complete information on any Victaulic product, write:

VICTAULIC COMPANY OF AMERICA

Dept. 91-11, P.O. Box 509, Elizabeth, N. J.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW

CLAYTON MARK

Parkerized

FITTINGS

- **RUST PROOF, CORROSION-RESISTANT**
- **CARBON AND ALLOY**
- **SCREWED AND SOCKET WELD**
- **2000, 3000, 4000, 6000 p.s.i.**

Now you can buy a complete line of *Parkerized* Fittings from the same source that has supplied you with high pressure Unions and Valves since 1912. In sizes ⅛" to 4", these forged steel, clean-looking fittings resist corrosion "forever" on shelf or in high-pressure steam, water, oil, gas and air applications. Eliminate duplicate paperwork . . . order all your piping requirements from your Clayton Mark Distributor. Have the best yet save time and money —specify Clayton Mark!

AVAILABLE IN 50 STATES AND THROUGHOUT THE WORLD

CLAYTON MARK

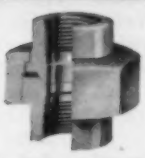
AND COMPANY

1914 DEMPSTER STREET · EVANSTON, ILLINOIS · U.S.A.

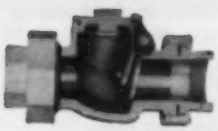
PUMPS · WATER WELL SUPPLIES · CONDUIT · UNIONS · TUBING

HOT FORGED STEEL HIGH-PRESSURE UNIONS AND VALVES

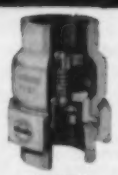
"PETRO" CARBON STEEL UNION



PETRO" STAINLESS STEEL UNION



SWING CHECK VALVE



"PETRO" CHECK VALVE

"BEVELED" ORIFICE UNION

Dilemma of Oil Industry From Broker's Viewpoint

A. RHETT duPONT

NOT VERY MANY PEOPLE in the United States paid more than casual attention to the recent announcement that the posted price for Middle East crude oil had been reduced. Most knew that this country was more or less insulated from world prices by our quotas on imports.

The vast majority shrugged and thought, "This is just another gambit in the international oil game."

Even those who looked more deeply were likely to say, "Oh, well, everyone was giving discounts off the posted price; this just faces up to the facts and makes it official."

All true enough — but a long way from the whole truth. This was a lot more than "just a gambit" or "facing up to facts."

The whole economy of at least half a dozen Middle Eastern states is based on oil; several others, there and elsewhere, depend very substantially on oil revenues. Their incomes fluctuate directly with the posted price. Thus Saudi Arabia or Iran or Kuwait has no worry about how much oil is sold at a discount from the posted price; as long as that official quotation is maintained (no matter how fictitiously, the sultans and the sheiks and the shahs have only to know how many barrels came out of the ground to calculate their incomes.

For this reason, any cut in output or in the posted price looms more as a political decision than a simple matter of business policy. Either may risk reprisals.

Many an oil man in recent weeks has been heard to mutter that he wished the responsibility for such decisions rested on the governments concerned and not on businessmen. If that were the case, then the repercussions would be at the government level (where they may wind up in any event) instead of falling on the oil companies.

That's why the story of this cut in prices, even told in simplest outline, has a sort of fairy-tale quality.

In the first place, the big companies producing oil in the Middle East (and in the Caribbean) had been selling to independent refiners and marketers at discounts for a long while. The reason was a world-wide surplus of petroleum and its products. The surplus continued to pile up because to cut output would be to court reprisal.

Meanwhile, the fiction of the stable price was maintained by producers selling to their refining and marketing affiliates at the official figure. This put the affiliates on a spot, profit-wise, in competitive markets. But in sheltered markets they could sell at prices based on what they were paying parent companies for crude.

This juggling act was upset, typically enough, by the Russians. They offered cut-price oil to India. But India hasn't yet any refineries of its own, relying on the plants operated by affiliates of three big international producers. These plants were paying the official price for Middle East crude and pricing products accordingly.

When India asked them to run the Russian oil, they refused. The Indian government made no overt threat at seizure, but suggested that the companies had better set prices at "more competitive" levels. There was nothing for it to do but to comply. Esso took the initiative, thus formally shooting a gaping hole in the price umbrella by cutting the cost of Middle East crude sold to its Indian affiliate.

If a price cut could be counted on to discourage excessive production, that would be one thing. But it is not much easier to cut output than to cut prices. It's a rare country that isn't looking for ways to make more rather than less out of oil. With the picture of Cuba and Castro before their eyes, oil men are in no mood to do anything which invites expropriation or even renegotiation or compulsory revision of the time-honored 50-50 profit split.

This formula, in fact, already is under too much pressure for comfort. The Italians and the Japanese both have signed deals providing oil countries with better than 50-50 arrangements, while the latest tax imposed by Venezuela squeezed 69¢ out of each 1959 sales dollar realized by companies operating there.

Venezuela, incidentally, is one of the few producing countries willing to see output cut as a means of supporting prices. It has, in fact, tried without success to interest the Arab states in a proration scheme.

The oil companies, for their part, are victims of the industry's paradoxical economics. Even though there is too much oil now, they have to go into new countries, investing heavily in the search for oil for fear competitors will get the jump on them. When they find it, they have to build refineries and distribution systems in every market that opens up for fear a competitor may tie that area up under an exclusive marketing agreement. And there's always a tendency to feel that it's advisable to get oil out of the ground sooner rather than later for fear the producing country will demand a new split on profits — or, at the very least, a lot of new taxes and fees or changes in the concession.

As though all this were not vexing enough, along come the Russians with their oil as a weapon of economic war — and with price a secondary matter, if, indeed, it matters at all. And as the game is developing, the Italian state monopoly seems in a fair way to become Russia's dupe, however innocently.

Russia has been a fairly large exporter for years, but most of this oil had until recently gone to other Soviet bloc countries. But its shipments now make up 2% to 3% of Free World imports and more of this oil is sure to be offered as Russian output rises. Sales to Cuba and Brazil (mainly on barter) and the offer to India reveal both the political and economic motivations of this trade.

The political aspect makes the Italians appear catspaws as they deal with Russia. If they bought only for their own use (and were willing to risk the continuity of Soviet supplies), that would be one thing. But when they buy cut-rate Russian oil in the hope of winning third markets (as they seem now to hope to be doing in Britain) they find their own allies viewing their actions askance.

This then, is hardly a game for amateurs. In fact, international oil men feel that they have more often to be diplomats than businessmen. ★ ★ ★

EDITOR'S NOTE: Mr. duPont, senior partner of Francis I. duPont & Company, nation-wide security and commodity brokerage firm, discussed this question in the September issue of Investor-news, the firm's magazine.

Laugh with Barney

It isn't true, as the saying goes, that alcohol and gasoline don't mix. Actually they mix, but they don't taste good.

"He's a psycho-ceramic."
"What's that?"
"A crackpot."

Husband, struggling with budget, said to his wife: "We should have saved during the recession so we could live through this prosperity."

"That salesman! I've never heard a man talk so fast in all my life."
"Why shouldn't he? His father was an auctioneer and his mater was a woman."

Killing time is suicide on the installment plan.

You have reached middle age when you've learned how to take care of yourself and intend to begin almost any day now.

Statement Required by the Act of August 24, 1912, as Amended by the Acts of March 3, 1933, July 2, 1946 and June 11, 1960 (74 Stat. 208) Showing the Ownership, Management, and Circulation of

PETROLEUM ENGINEER FOR MANAGEMENT

Published monthly except semi-monthly in July, at Dallas, Texas for October 1, 1960.

1. The names and addresses of publisher, editor, managing editor, and business managers are:

Publisher: The Petroleum Engineer Publishing Co., 800 Davis Bldg., Dallas, Texas.

Editor: J. E. Kastrop, 800 Davis Bldg., Dallas, Texas.

Business Manager: Joe B. Woods, 800 Davis Bldg., Dallas, Texas.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.)

American Security Life Insurance Company, Marshall, Texas.

Fidelity National Life Insurance Company, 403 S. Akard St., Dallas, Texas.

Investors Life Insurance Company, 403 S. Akard St., Dallas, Texas.

Reserve Life Insurance Company, 403 S. Akard St., Dallas, Texas.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

Reserve Life Insurance Company, 403 S. Akard St., Dallas, Texas.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required by the act of June 11, 1960 to be included in all statements regardless of frequency of issue.) 4,347.

Joe B. Woods, Business Manager

Sworn to and subscribed before me this 23rd day of September, 1960.

(SEAL) Grace H. Harkins
Notary Public, Dallas County.
(My commission expires June 1, 1961)

Look into Lonergan Bellows Valves

Seven exclusive features reduce maintenance costs; provide increased valve versatility.

Like all bellows valves, Lonergan valves are designed to keep corrosive or viscous fluids away from working parts. In addition, they provide a balancing action against a variable back pressure. The similarity between Lonergan and any other bellows valve ends there. *Only Lonergan valves provide:*

1. *Saf-T-Alarm to warn of bellows failure. Alarm may be remotely located. (Optional at extra cost.)

2. Complete interchangeability with conventional valves of the same series.

3. Versatile cap arrangement. Bolted cap is standard and is interchangeable with a packed cap without taking the valve off the line or out of service. Gag facility is included.

4. *Simplified nozzle replacement due to an exclusive knockout feature. (Optional.)

5. A Hydro model; a patented, true, non-chattering liquid valve. Elimination of chatter ends bellows failure due to excessive flexing.

6. Reserve seating surface obtained from a built-in spare disc.

7. PVC trim, where pressure-temperature conditions permit.

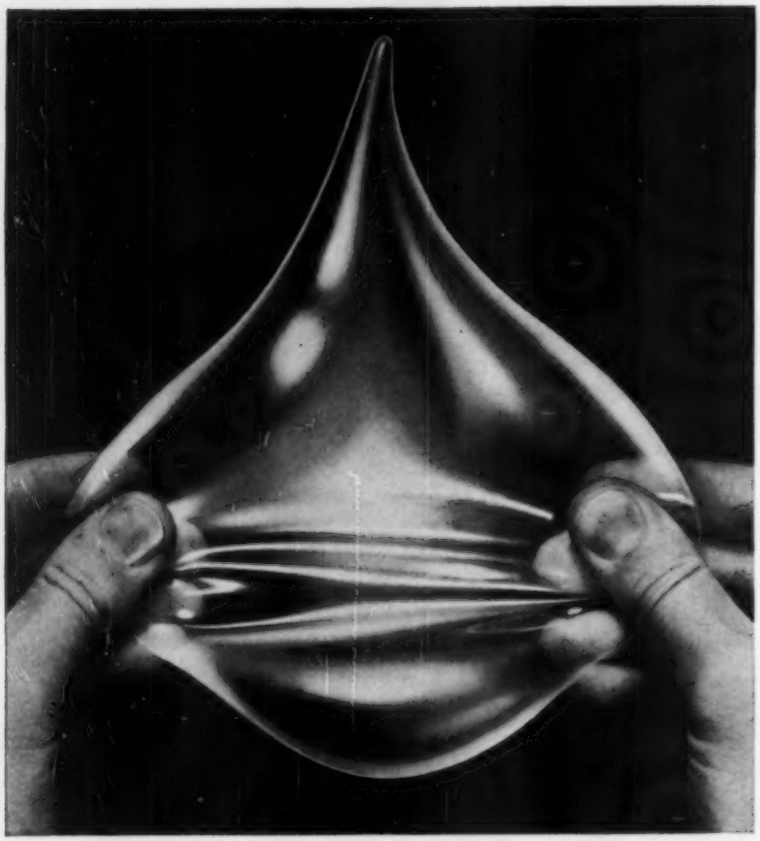
These seven features mean economy for Lonergan valve users—in first cost; in operation; in maintenance. If your plant uses bellows valves, then it will pay you to investigate Lonergan. Series DB bellows valves are described in a new bulletin. Series D valves, available without the bellows, are also described. Write for your copy today.

**Patent Pending*

Lonergan

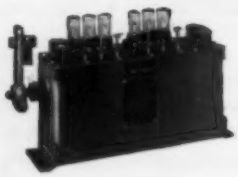
J. E. LONERGAN COMPANY, 205 RACE STREET
PHILADELPHIA 6, PENNA. • SINCE 1872

How to STRETCH



a drop of oil...

Manzel force-feed lubricators squeeze the full potential out of every drop of oil you purchase. Model "94", for example, pumps against pressures up to 3,000 pounds, handling any grade of oil from the lightest mineral oil to the heaviest cylinder stock with the same regularity. Model "94" starts, stops, speeds up and slows down in synchronization with your machinery. Every change in engine speed brings a corresponding change in the amount of oil delivered. For details on our whole line of *responsive, responsible* lubricators, write for our catalog. Manzel, 255 Babcock Street, Buffalo 10, New York. For the most efficient lubrication,



ask the man from

UNIT OF HOUDAILLE INDUSTRIES, INC.

Manzel

SPECIALISTS IN LUBRICATORS AND METERING PUMPS SINCE 1898

The art of making "NO" sound like "YES"

You have to say NO nearly every day and the way you say it may mean your success or failure

Saying NO nicely — but firmly enough to make it stick — is an art few of us have mastered. The increased tempo of the world today is forever forcing us into spots where we must say No due to many valid reasons.

Since we can't escape the word itself, how we choose to say it will very much determine whether we keep friends and peaceful and happy relations at home and at work.

To use the blunt monosyllable with a self-righteous feeling of frankness can sometimes be misinterpreted as boorishness. Just as bad is to delay the NO. "A little later" never comes.

Actually, if anyone is willing to expend some patience and imagination there are half a dozen RIGHT kinds of NO. Each is tailored to fit different circumstances and temperaments.

The nicest NO is the SYMPATHETIC NEGATIVE. Soft and graceful, it is particularly applicable to emotional people and emotional situations. This is the NO that has been mastered by most doctors. A full and sympathetic explanation should cover the problems of both parties. It should leave the person making the request feel that he has made the wise decision himself.

The second NO is the INTELLECTUAL NO. Basically this involves backing up the NO with the facts and figures and logic. An example here is the irrate employee who crashes into the boss's office for a raise and 10 minutes later emerges without the raise but smiling and a 100 percent company man.

The NO WITH HOPE (a variation

EDITOR'S NOTE: This is our version of a piece by Sergeant Doug Harvey, a public relations officer of the RCAF's Air Defense Command. We think it is good advice for all.

of the above). Actually a compromise. An example of this would be the following: A newsman wants to cover a certain event and you can't accommodate him with transportation. Rather than say no dice, you both sit down and figure out a way around the situation. You might delay the trip until transportation becomes available, emphasizing the better time element. There are many ways in which this NO serves superbly. The only drawback with this type of NO is that it presupposes enough intelligence and imagination to foresee the future. With the impetuous and unimaginative, the fourth kind of NO is better.

The NO-WITH-HELP. In essence it is this: If I have to say NO on this request, maybe I can give the fellow something else. Not what he asks for but some privilege that will interest him and not hamper work to be done. Thus, I assuage his feelings and also prove that my heart is in the right place. Many good supervisors practice this admirably. It works with your friends, too. It's as simple as, "I can't go bowling with you tonight, what about Friday?"

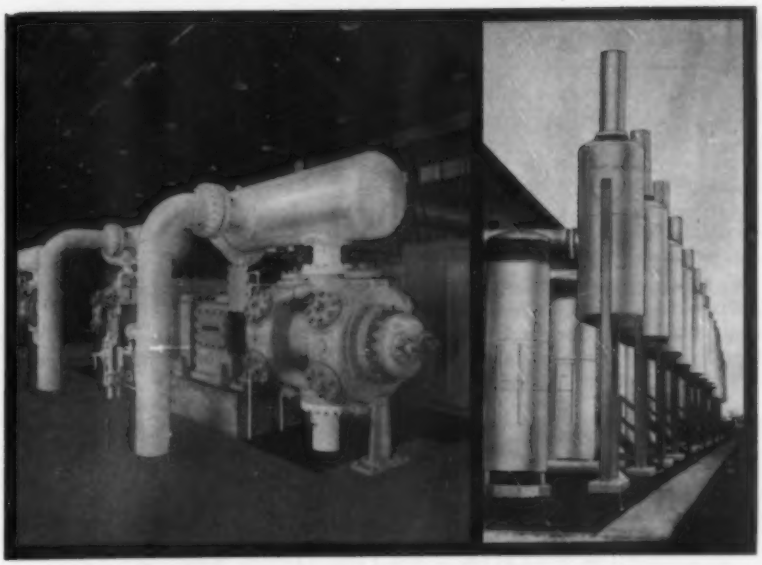
The *FAIR-PLAY NO.* This one is well known and often practised. No one gets preferential treatment. No discrimination on privileges, fair play to all. A policy of fairness to all rigidly adhered to will make the biggest grumbler cheerfully accept an honest NO. But you have to stick to this and that is not easy.

The PSYCHOLOGICAL NO. A NO can be humiliating to a man's pride. You think you're important; then the NO puts you in your place. Here is where the psychological NO can work wonders. You have to say NO so you show your desolation by assuring the person that there is no one whom you'd rather oblige. You bolster his ego with your 'this-hurts-me-more-than-it-does-you' NO. Rightly applied this NO will bring an acceptance from the receiver that will leave him consoling you about the fate that makes it impossible for you to serve him.

There is one kind of NO which can never be justified under any circumstances. This is to say YES when you have no intention of carrying out the promise. Rather than lie, be a man about it and just say 'NO.'

But use the short and ugly word as sparingly as possible. No other so quickly and devastatingly negates the things that most of us live by — faith in ourselves and others; hope in our plans and the future.

Whatever we do to soften the impact of the short, harsh word is not deceit but charity to others, as well as profit to ourselves. ★ ★ ★



ELIMINATE PULSATION AND NOISE WITH BURGESS-MANNING SNUBBERS

Burgess-Manning Pulsation Snubbers are the most effective control measures available to eliminate pulse-induced vibration. Equipment performs better, operating and maintenance costs are reduced, breakdowns and repairs are fewer, and even structural damage to buildings and foundations is prevented. Similarly, when a Burgess-Manning Silencer is installed to eliminate excessive noise, employees work more efficiently, with fewer accidents and errors, production is usually increased, and a plant's labor and community relations are improved. ■ If noise or vibration from the intake or discharge of internal combustion engines, blowers, turbines, compressors, gas or steam vent valves, pressure regulators, and similar equipment is a problem with you, contact Burgess-Manning. Nowhere in the world will you find a company better qualified, with more experience, a better engineering background, and a wider range of products for noise and pulsation attenuation. ***Pictured: Burgess-Manning Pulsation Snubbers, Filter-Silencers, and Exhaust Silencers on gas-driven compressors in petroleum pipe line station.***

SALES ENGINEERING REPRESENTATIVES WORLD-WIDE

Oakland • Los Alamitos, Calif. • Denver
Bellevue, Wash. • Charleston, West Va.
Libertyville, Ill. • Odessa, Tex. • Dallas
Houston • Shreveport • Tulsa • Detroit
Chattanooga • Ames, Iowa • Kansas City
Cleveland • St. Louis • Decatur, Ga.
Elizabethton, Tenn. • Chicago • Boston
Pittsburgh • Buffalo • New York City
Montreal • Toronto • Calgary
Edmonton • Mexico City • Milan • Rome
Hinckley, Leics., England • The Hague
Paris • Frankfurt/Main • Braunau/Inn
Madrid • Vienna • Algiers

Industrial Silencer Division
BURGESS-MANNING COMPANY
The Sound Engineering People
General Offices: 9241 Sovereign Row, Dallas 7, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Management Personals

Herbert F. Beardmore, was elected a vice president of Gulf Oil Corporation. He will be in charge of production operations in the U. S. with headquarters in Houston. Formerly manager of Gulf's Houston production district, he succeeds **Robert L. Boggs** who retires.

K. E. Rotegard is appointed manager of the domestic service department, Gulf Oil Corporation. The department is responsible for handling all advisory and service elements for domestic operations with Houston offices as headquarters.

H. F. Beardmore

K. E. Rotegard

George O. Relf Jr., moves to administrative vice president. He succeeds **Newby G. Simpson** as coordinator of the production department. Simpson becomes manager of Gulf's production operations in Libya.

S. G. Sanderson is new president of Stekoll Petroleum Corporation. In addition to his position as president, Sanderson joins the company's board. He recently retired as manager of Gulf Oil Corporation's Houston division. **Marion H. Stekoll,** former president of Stekoll Petroleum, will remain with the company as chairman of the board of directors.

Dr. James A. Tong, president of the Mobil Oil Company of Venezuela, retires January 1. The University of Arizona awarded him the professional degree of geological engineer in 1945 and the Alumni Achievement Award in 1958. The university plans to award him its 75th Anniversary Medallion of Merit at a Pan American Convocation to be held in December.

Tilden Cummings, president and director of the Continental Illinois National Bank and Trust Company of Chicago, has been elected a member of the board of directors of Northern Natural Gas Company.

Lewell Adair was appointed manager and vice president of Libyan Atlantic Company, responsible for all operations—exploration, drilling, production, and governmental relations connected with the company's 6½-million acre concession offshore Libya. His headquarters will be in Tripoli.

Grove Lawrence was elected president of Pacific Natural Gas Exploration Co., newly formed subsidiary of Pacific Lighting Corp. Elected with Lawrence as officers were **Stuart T. Peeler,** vice president and secretary and **Harry L. Bosshard,** treasurer and assistant secretary. **Thomas A. Johnson Jr.** was named field manager for the new company.

Harold F. Wiley, director of the analytical & control division, Consolidated Electrodynamics Corporation, is named a vice president of the firm. Wiley continues to direct activities of the A&C division, reporting to **Robert H. Garretson,** executive vice president of CEC, a subsidiary of Bell & Howell Company.

Earl F. Mayer was appointed controller of the Axelson Division of U. S. Industries, Inc.

Mayer has been controller for the past two years of the Louisville Cement Company.

ANNOUNCING
Frank Wheatley's
NEW LINE OF
SPHERE CLEAR
CHECK VALVES
WITH NEW SWINGING DOOR PRINCIPLE!

NEW!

Developed specifically for use on lines where ball-marking of interface or batch change is employed, and for easy passage of all conventional scrapers.

SINCE 1916
FRANK WHEATLEY
PUMPS & VALVES
TULSA 6, OKLAHOMA

Tulsa, Bartlesville, Calgary, Dallas, Edmonton, Evansville, Farmington, Houston, Lafayette, Los Angeles, New York City, Odessa, Shreveport, Wichita Falls, Carmi, Caracas, Mexico City, London.

Here's how Frank Wheatley's new SPHERE-CLEAR Check Valve works . . . (1) Ball enters valve . . . (2) Ball contacts conduit-shaped clapper. The clapper, floating on thrust bearings, is hinged on an 8° angle to offer 90% less dead weight resistance . . . eliminates sticking or jamming . . . (3) Clapper completely recesses into valve body allowing full ID passage and reducing fluid by-pass 85%.

Available: 1" to 36" in steel, semi-steel, or aluminum bronze for all API, ASA fittings. Write to Box 1948, Tulsa, Oklahoma for further information.

▸ **Ralph J. Schilthuis** has been named vice president for production by Humble Oil and Refining Company, a new post. Schilthuis is responsible to Humble's board of directors for coordination of all production activities. He was formerly executive vice president of the Humble Division.

R. J. Schilthuis

John M. Sprague moves to Humble as Washington representative. Sprague is a former controller, area manager and regional vice president of Humble's Carter Division, Tulsa, Oklahoma. **William R. Veal,** associated with Sprague, will serve as attorney for Humble's Washington office.

▸ **George S. Trees** was elected a vice president of Chicago Bridge & Iron Company. He was named a regional sales manager earlier this year.

▸ **Lawrence A. Kimpton** joins Standard Oil Company (Indiana) as general manager of planning, supervising activities concerned with long range planning and industry and general economics. He continues as a member of Standard's board of directors.

▸ **John McVean Laurd** was named to the board of BP Exploration Company and **John Moffat** to the boards of BP Refinery (Llandarcy) Ltd., and BP Refinery (Kent) Ltd., and BP Refinery (Grangemouth) Ltd. Laurd and Moffat are respectively general managers for exploration and refining in the BP Group's head offices in London.

▸ **W. Turner Clack, John L. Kalb, Hugh H. Millar** and **H. R. Milner** are the newly appointed board members of Husky Oil Company. They replace **Geo. S. Buchanan, Lawrence W. Lee, Kenneth M. Johnston** and **Paul J. Guthrie.**

▸ **Dr. Paul Davidson** was appointed assistant director of Continental Oil Company's economics division.

Formerly assistant professor of economics at Rutgers University, he will headquarter in Houston and will be in charge of the general economics section of Conoco's economics division.

▸ **Robert F. Ichord** was named manager of Shell Chemical Co.'s newly formed staff administration department. Ichord joined Shell in 1930. Prior to his new appointment, he was manager of the organization division.

▸ **Fred B. Korsmeyer,** manager of employee relations for Mobil Oil Company, becomes manager of the corporate employee relations department of Socony Mobil Oil Company, Inc. **Clyde Port,** general manager of Twin Cities marketing division, succeeds Korsmeyer, and **William A. Greeley,** manager of Mobil Oil's resale development department, succeeds Port.

▸ **A. F. Hamilton** was appointed vice president and general manager of Texas Gas Exploration Foreign C. A. He was formerly an assistant vice president of Renwar Oil Corporation.

A. F. Hamilton

W. G. Shain

▸ **William G. Shain** was made director of public relations of Atlantic Refining Company. He succeeds **Richard Rollins,** who is retiring. Shain formerly headed Atlantic's foreign personnel division.

H-O-H*

GLUCOSATES*

Improved Through Research
Proven By Performance
The Best For Your
Water Treating Problems

WE READ WATER* H-O-H ESTABLISHED 1931

Write for literature on your letterhead.

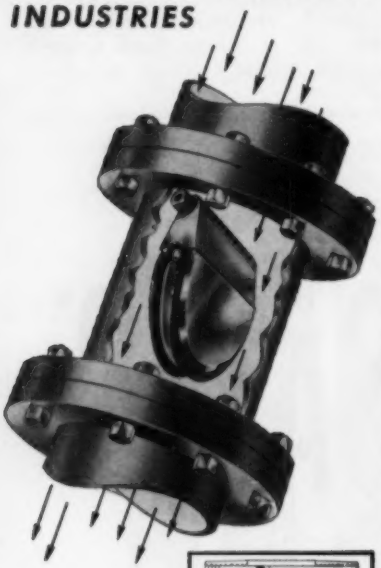
*REG. U.S. PAT. OFF.

D. W. HAERING & CO., INC.
ANALYSTS · CONSULTANTS · MANUFACTURERS
P. O. Box 10337
San Antonio 21, Texas

A BETTER PERFORMING

CHECK VALVE

FOR THE PETROLEUM INDUSTRIES



SILENT • SEATLESS • LOW PRESSURE DROP

Technocheck®

OUTPERFORMS •
OUTWEARS OTHER VALVES •
COSTS LESS TO MAINTAIN!

In field service in a wide range of water, gas, air and oil applications, Technocheck's performance and reliability are unsurpassed. Its exclusive design eliminates valve seats. Tight sealing, low pressure drop and long life with low upkeep are some of its important characteristics.

Made in a variety of metals and in Polyvinyl Chloride. Standard and custom models in sizes ranging from 1" to 36".

Write for additional information

Techno Corporation Dept. PE
16 West 5th Street, Erie, Pa.

▸ **W. D. McEachron** was appointed manager of longrange planning, **C. E. Liebacher** as economist-industry economics, and **C. R. Jung** as economist-general economics, with Standard Oil Company (Indiana.) McEachron, Leibacher, and Jung are presently with the company.

▸ **William G. Hamilton, Jr.,** president of American Meter Company, and chairman of the board of Canadian Meter Co., Ltd., was re-elected a director of the American Gas Association.

▸ **U. S. Industries, Inc.** has announced the consolidation of their Garrett Oil Tools and Axelson Divisions. The two will form one major operation to produce, sell, service and distribute all oil and gas production, transmission and allied petroleum equipment.

▸ **Dudley Tower** was elected president of Union Oil Company of California. He succeeds **Reese H. Taylor,** who has been both chairman and president of Union since April 1960.

▸ **B. A. Warren** was named general manager of Esso Standard's purchasing department. Warren succeeds **Haylett O'Neill Jr.,** who returns as purchasing agent of the Humble Oil Division in Houston.

▸ **Clinton Dow Mims** was appointed assistant general manager, producing department, of Standard Oil Company of California, Western Operations, Inc. Mims was formerly vice president of production for Standard Oil Company of Texas, a Standard of California subsidiary.

▸ **Charles C. Snider** was elected vice president of Consolidated Electrodynamics Corporation, a subsidiary of Bell and Howell Company. He reports to **Everett F. Wagner,** vice president of Bell and Howell's International division.

DEATHS

▸ **John A. Ritter,** 73, retired general operating superintendent for Sun Oil Company's Southwest Division, died October 1, Dallas, Texas.

▸ **Dr. John T. Lonsdale,** 64, University of Texas geology professor and Bureau of Economic Geology director, died October 5 at his home in Austin.

▸ **Whitney M. Elias,** 49, vice president, production, of Pan American Petroleum Corporation died September 22 in Paris, France.

▸ **Herbert Warren Ladd Sr.,** superintendent of materials for Pan American Petroleum Corporation, died at his home in Tulsa, Oklahoma.

COUPLINGS BY Wheeling

WHEELING MACHINE PRODUCTS CO.

Wheeling, West Virginia

West Coast Factory: Woodlake, California

MINIATURE 2-WAY RADIO SYSTEM lets you SPEAK and be HEARD under ANY NOISE CONDITIONS!

the SEISCOR TELEPATH

. . . is a portable industrial-type communications system that becomes a part of your wearing apparel. Crystal-controlled circuit plus noise-cancelling mike and earphones make it the best way to communicate in poor visibility or high noise conditions!

- Fully transistorized printed circuit
- Crystal-controlled superheterodyne receiver
- Crystal-controlled transmitter
- Long battery life
- For any single frequency between 28-55 mc., A. M.
- No license required on 27 mc. units.
- Priced from $350.00 per unit.

MODEL HR
Hardhat with built-in transceiver, antenna, earphones and mike. High and low noise level models available.

MODEL BR
Belt-clip transceiver and headset with built-in antenna, earphones and mike. High and low noise level models available.

Let Seiscor Engineers analyze your short-range communications problems. Example: Special units have been designed into protective clothing for crash-crew fire fighters.

FIND OUT TODAY HOW TELEPATH CAN IMPROVE YOUR SHORT RANGE COMMUNICATIONS!

Write for name of nearest TELEPATH dealer, and complete information on versatile TELEPATH communications.

SEISCOR
A DIVISION OF SEISMOGRAPH SERVICE CORPORATION
BOX 1590, TULSA, OKLAHOMA

CLASSIFIED

ADVERTISING SALES OR PROMOTION

Trainee for leading oil, gas, petro/chem publications. Must be personable, intelligent, tactfully aggressive. He could be a graduate in advertising, marketing, journalism, or a petroleum, mechanical or chemical engineer presently employed in the oil-gas industry. Writing aptitude important. Excellent opportunity for young man of right qualifications. *Apply by letter and resume to* **P. O. Box 1589, Dallas, Texas,** *sending qualifications, telephone number and photo. Replies will be held in confidence.*

FOR SALE

1 Coleman Instrument Co. Controlled Temperature Bath for calibrating BHP instruments with Model "H" Coleman 10,000# Dead Weight Tester. *Send bids to* **Gulf Oil Corp.,** *Attention* **T. R. Coffield, P. O. Box 648, Laurel, Miss.**

OPERATION ENGINEER OR SERVICE ENGINEER TECH. SALES-SERVICE REPRESENTATIVE

Experienced in start-up, check-out and servicing of chemical plants and equipment. Field man and trouble shooter for the engineering department. BS 1936, Member ACS. Traveled inside and outside U. S. for extended time periods. Languages. **H. J. Comrie, 514 South Main Street, North Syracuse, N. Y.**

Four Fine Facilities in PITTSBURGH

ALLEGHENY MOTOR INN Opposite Greater Pittsburgh Airport. 60 air-conditioned rooms, tile bath, TV, phone. Year-round swimming pool. Courtesy car to and from airport. **AMherst 4-5152**

HOTEL PITTSBURGHER In the heart of the Golden Triangle. 400 outside rooms, bath, TV, radio, air-conditioning. General Forbes Lounge & Dining Room. **ATlantic 1-8970**

JACKTOWN MOTOR HOTEL 1 mile west of Irwin Interchange on Route 30. 60 air-conditioned rooms, TV, telephone, combination tile bath. Facilities for dining and group parties. **UNderhill 5-2100**

HOTEL PITTSBURGHER MOTEL Opposite Greater Pittsburgh Airport. 56 air-conditioned rooms, tile bath, radio, TV, phone. Courtesy car to and from airport. **AMherst 4-6152**

KNOTT HOTELS

*Teletype Service. Telephone any Knott Hotel. All Knott Hotels and offices in U.S. connected by teletype.

Joseph F. Duddy
General Manager

AMERICAN®

PRESSURE and TEMPERATURE RECORDERS

American® single and two-pen *Pressure Recorders* for pressures from 30 inches vacuum to 10,000 psi.

- Pressure elements individually calibrated over full range.
- Variety of chart drives available.
- Helical elements of different ranges are interchangeable.
- Stainless steel pen arms with span and linearity adjustments.
- Aluminum dust and moisture-proof case.

American® *Temperature Recorders* for an accurate record of flowing temperatures.

- No ambient temperature errors.
- High sensitivity and torque—fast speed of response.
- Standard 0-150°F. range. Other ranges available by request.
- 24-hour mechanical or 110-v. 60-cy. electric chart drives.

Ask for Bulletins 400 and 408

AMERICAN® METER COMPANY
INCORPORATED (ESTABLISHED 1836)
General Offices: Philadelphia 15, Pa.
Sales Offices in Principal Cities

Specialists in

NEEDLE VALVES

Valves for:

- Liquid Gases
- Remote Control
- Corrosive Fluids
- Hydraulic Systems
- Pneumatic Systems
- Special Applications

Wide Range of Specs Available:

Pressures: Vacuum to 30,000 psi
Temperatures: —320°F to +1200°F
Sizes: ⅛" thru 1" in pipe threads and many types of tube ports
Materials: Carbon Steel, 4140, Monel, Aluminum, Brass, and various types of Stainless Steel
Packings: Teflon, Asbestos types, and other materials
Mountings: Regular and Panel
Dealers in all major cities

SOFT SEAT NEEDLE VALVE — Vacuum to 6,000 psi, —100°F to +500°F
FAST SHUT-OFF NEEDLE VALVE
Cam action lever handle, 10,000 psi
REMOTE CONTROL NEEDLE VALVE
Holds 10,000 psi with 50 psi on diaphragm
CRYOGENIC NEEDLE VALVE
-320°F, 10,000 psi

Write for Catalog

Since 1946 **DRAGON** *ENGINEERING CO., INC.*
P.O. BOX 185, NORWALK, CALIFORNIA

SPECIALIZED MANAGEMENT
works for
Oil Properties
in Trust

Personal Trust Department
MERCANTILE
NATIONAL BANK
DALLAS, TEXAS

OIL / GAS
WATER
PRODUCTS
PIPELINE SYSTEMS

WILLIAMS BROTHERS

ENGINEERS - CONSTRUCTORS
NBT BUILDING, TULSA, OKLAHOMA / CABLE: WILLBRO
NEW YORK / WASHINGTON / LOUISVILLE
MINNEAPOLIS / CARACAS / BOGOTA / LA PAZ / EDMONTON
CALGARY / LONDON / ANKARA / TEHRAN

relief *from* **tension**

Let the radioactive waters of world-famous Hot Springs National Park banish all your aches and pains due to tension and occupational fatigue—ease arthritis, rheumatism and high blood pressure. Countless thousands have benefited from these wonderful thermal baths— Superb bathhouse right in hotel.

All sports available, including golf with club privileges, game fishing, and water sports. Entertainment and social diversions.

THE *Arlington* HOTEL and BATHS
HOT SPRINGS
NATIONAL PARK ARKANSAS

Write for Your Free Color Folder

OUR OWN
TWIN CASCADE SWIMMING POOLS
You will enjoy the new twin cascade temperature-controlled swimming pools, patio and sun decks accessible from the Arlington.

R. E. McEACHIN
General Manager

Books To Read . . .

Job Attitudes, Review of Research and Opinion, *by Frederick Herzberg, Bernard Mausner, Richard O. Peterson and Dora F. Capwell. Published by Psychological Service of Pittsburgh, 355 Fifth Avenue, Pittsburgh, Pennsylvania. Pages, 269. Price $7.50.*

Job attitude research is highly important to any person dealing with personnel problems. This book is part of a report on research and consulting experience at Psychological Service as well as observation of others working with industrial problems. Attitudes of people toward their jobs in some instances can be the key to progress or retrogression. Some of the graphs shown are eye-openers. The figure showing morale according to age begins high, slumps to its lowest point between the 20 to 29 age group, then climbs again.

Another phase is the relation of morale to productivity. It is a revelation to know nearly half of workers covered in study do not have a high morale to be productive or may even be more productive with low morale.

Clays and Clay Minerals, *proceedings of the Seventh National Conference on Clays and Clay Minerals, Washington, D.C., edited by Ada Swineford. Published by Pergamon Press, 122 East 55th Street, New York 22, New York. Pages, 364. Price, $8.50.*

This is the latest in a series published by Pergamon on the proceedings of the annual meetings of the Conference on Clays and Clay Minerals sponsored by the Committee on Clay Minerals of the U. S. National Academy of Sciences of the National Research Committee. Although a wide variety of topics was discussed at the conference, Miss Swineford has gathered together the most pertinent information brought forth at the proceedings which stressed regional clay mineralogy, the effect of saline water on clay minerals, genesis and identification of soil clays and viscosity of clay suspension.

The Nature of Science, *by David Greenwood. Published by Philosophical Library, 15 East 40th Street, New York 16, New York. 95 pages, price $3.75.*

This might be called an off-beat scientific essay, or a collection of essays. The emphasis is on the linguistic aspects of science and mathematics.

In the introduction and on the cover there is mention of theories of syntax and semantics as applied to the language of modern science. This is our special interest but we found the discussion here more specialized, limited to special scientific phases. The author is a London product, and studied at Oxford, London and Nottingham. He is now a teacher at the University of California, Los Angeles, and secretary of the Los Angeles Centre of the Royal Institute of Philosophy.

"Resistivity Determinations from Electric Logs," *published by Hubert Guyod, consultant, P. O. Box 282, Bellaire, Texas, with 127 figures or charts, 42 sample logs. Pages of text, 52. Price $20.*

Book was prepared as a field manual for six major oil companies which have now released it for sale to the public. It gives the background necessary for the practical use of resistivity curves, and fundamental data for determining resistivity of single beds and of multiple layer formations. At the time the material was gathered, there were not enough data available on invaded beds, so that only a limited number of analysis charts are included for such beds. Typical logs are given for single beds (invaded or non-invaded), multiple beds and sandwich-type formations. "Analysis Charts" supplements this field manual. The two volumes supply all analysis data available at present for determination of resistivities from an electric log.

Established 1910 **Fifty-First Year**

Published October

"OIL AND PETROLEUM YEAR BOOK" 1960

Compiler: WALTER E. SKINNER

The 1960 issue contains:—

Complete and up-to-date particulars of 1,000 AMERICAN, CANADIAN, BRITISH and FOREIGN COMPANIES, engaged in all phases of the Industry

Map showing World Oil Supply and Demand for 1959

Chart giving Product Demand by end use U.S.A. and Europe for 1959

International Professional Services Section

350 INTERNATIONAL ADVERTISERS of Oilfield Plant, Equipment and Accessories, Builders of Refineries and Pipelines, Oil Brokers and Distributors

WORLD'S OIL PRODUCTION—Table showing annual Production of Crude Oil and Natural Gasolene 1950-1959

International "Buyers' Guide" containing over 2,000 selected Headings and Entries

800 pages
Bound in RED cloth

Price: SEVEN DOLLARS

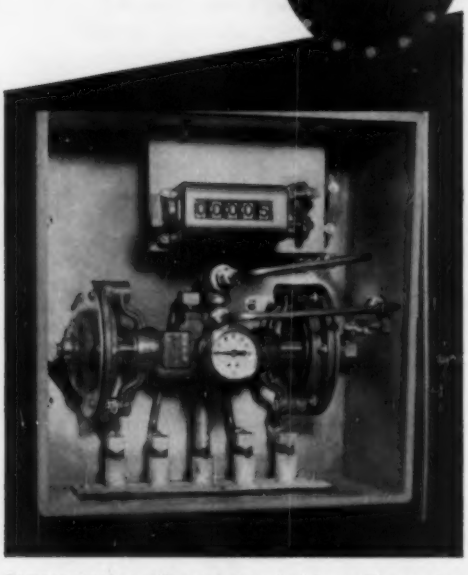
(Including Postage and Packing)

Obtainable from all Booksellers, or direct from the Publisher:

WALTER E. SKINNER, 20, Copthall Avenue, London, E.C. 2, England

National® LIQUA-METER*

Featuring National's New 3-Way Valve . . .



Tamper-proof, weather-proof control box with counter and rugged oil field controls.

1 bbl. capacity Liqua-Meter

For measuring liquid produced from individual wells or individual zones under a common royalty, the Liqua-Meter is recommended. Used in conjunction with a test separator or treater, the Liqua-Meter is used to determine the production of individual wells or zones without interrupting the production of other wells which continue to flow through the production separator. A counter records the number of dumps of the meter and is readily convertible to barrels run during the test.

Standard sizes are ½, 1 and 2 bbl. per dump. Other sizes on special order. Standard units available with two types of controls: Type "A" has one float, snap-acting pilot, manway and three-way valve. Type "B", shown, has two level controls, power booster relay, no manway, three-way valve, and meter control assembly and counter in tamper and weather-proof box.

Accurate within the limits prescribed by producer, royalty owner and regulatory body for measuring oil to be commingled.

A PLUS Value with all National Products . . . Engineers and field crews available from over 50 service and warehouse stocking points for complete units or spare parts to size, install and service National Liqua-Meters.

**Trademark of National Tank Company*

It's a National®

NATIONAL TANK COMPANY

DRAWER 1710

TULSA, OKLAHOMA

SERVICE

'ROUND-THE-CLOCK

Pumping unit value is only as good as the service that stands behind it. This is why Cabot maintains convenient 'Round the Clock service centers throughout the oil industry . . . service centers with complete stocks of Cabot parts and manned by factory trained personnel. This is your 24-hour-a-day guarantee that Cabot will deliver dependable pumping. CALL YOUR J&L MAN...

OIL FIELD PUMPING EQUIPMENT
CABOT
PAMPA, TEXAS
FRANKS

CABOT CORPORATION
MACHINERY DIVISION

A COMPLETE PACKAGE

Development of Welex's Acoustic Velocity Log adds a sparkling new service to the Welex Simplified Logging Program.

Formerly effective in 90 percent of today's wells,Welex's Simplified Program, with the addition of the Acoustic Velocity Log, now can give the best answers available in EVERY WELL—even the more complex, difficult-to-analyze wells.

The Acoustic Velocity Log accurately determines porosity by measuring the velocity of sound traversing formations. It also is useful to geophysicists for interpretation of seismic records.

As with the Welex FoRxo and Neutron Logs, porosity values can be read directly off the Welex Acoustic Velocity Log. When run in conjunction with the Welex Induction or Guard Log, the most important question—WILL THE WELL PRODUCE?—can be answered in minutes by use of the Simplified Interpretation Charts, or "pigtails," printed right on the log.

Most effective in formations with intergranular porosity, the Welex Acoustic Velocity Log can be run jointly with a self potential curve, gamma ray curve or caliper log for correlation purposes.

Next time and every time call your nearest Welex representative for the complete package of logging services that will answer the most important question—WILL THE WELL PRODUCE?

ORIGINATORS OF JET PERFORATING
Welex

WELEX, INC.

General Offices: 1400 East Berry, Fort Worth, Texas
In Canada: Welex of Canada, Ltd.

Cabot will deliver dependable pumping. CALL YOUR J&L MAN...
CABOT CORPORATION
MACHINERY DIVISION

Of Things To Come . . . In Oil

LOOK FOR CHANGES IN 1961 IMPORT QUOTAS . . . and, these changes might easily be downward as a result of the last two years' economic trend of the domestic producing picture. Government officials, cognizant of this trend are receptive to a reduction in 1961 imports for both crude and unfinished products. How much is anyone's guess. It's certain that any quota for "newcomers" will have to be squeezed from what probably will be lower allocations.

DRILLING COSTS CAN STILL BE REDUCED . . . and penetration rates further increased . . . without further squeezing the drilling contractor. New developments in tools and techniques open the door for a move off the plateau of existing penetration rates . . . and the application of new ideas in using existing equipment also point the way for reduction in costs. Use of improved hydraulics, application of variable rotary and bit weights, some of the new down-hole drilling devices, and an overall closer control of drilling every foot of the way are but a few of the ways under testing.

SLIMHOLE DRILLING INCREASING in spite of equipment and depth limitations, according to a survey by AAODC . . . which showed about 10% of wells drilled were in this category. Up to 43% savings can be made in slimhole completions . . . but, savings are not comparable in slimhole drilling. Equivalent bit life in smaller holes, hydraulic problems are two limiting factors. Look for new developments in both areas.

ON THE BRIGHTER SIDE OF OIL . . . if you're looking for a light of encouragement, here are two thoughts, from W. J. Goldston, president, Mid-Continent Oil & Gas Association: (1) petroleum executives are investing heavier in their own industry; and (2) the necessity of finding 52 billion bbl of reserves in next 10 years to maintain our relative position.

OFFSHORE UNDERWATER STORAGE FACILITIES TO INCREASE, if current planning and construction is any indicator. Economics of producing offshore crude in large tanks which form foundation of large production platforms look good in several locations. Ocean Drilling and Exploration is currently constructing such a production barge in New Orleans; The California Company will follow shortly with its version of a similar combination production-storage platform that can be floated to location and sunk.

OIL DEMAND OUTLOOK STEADY . . . for last quarter 1960 . . . forecasts IPAA . . . but, will be same as third quarter, averaging 10,400,000 bbl daily, about 4% above last quarter of last year.

Trinity
LITE-WATE
A Complete
LOW-DENSITY CEMENT

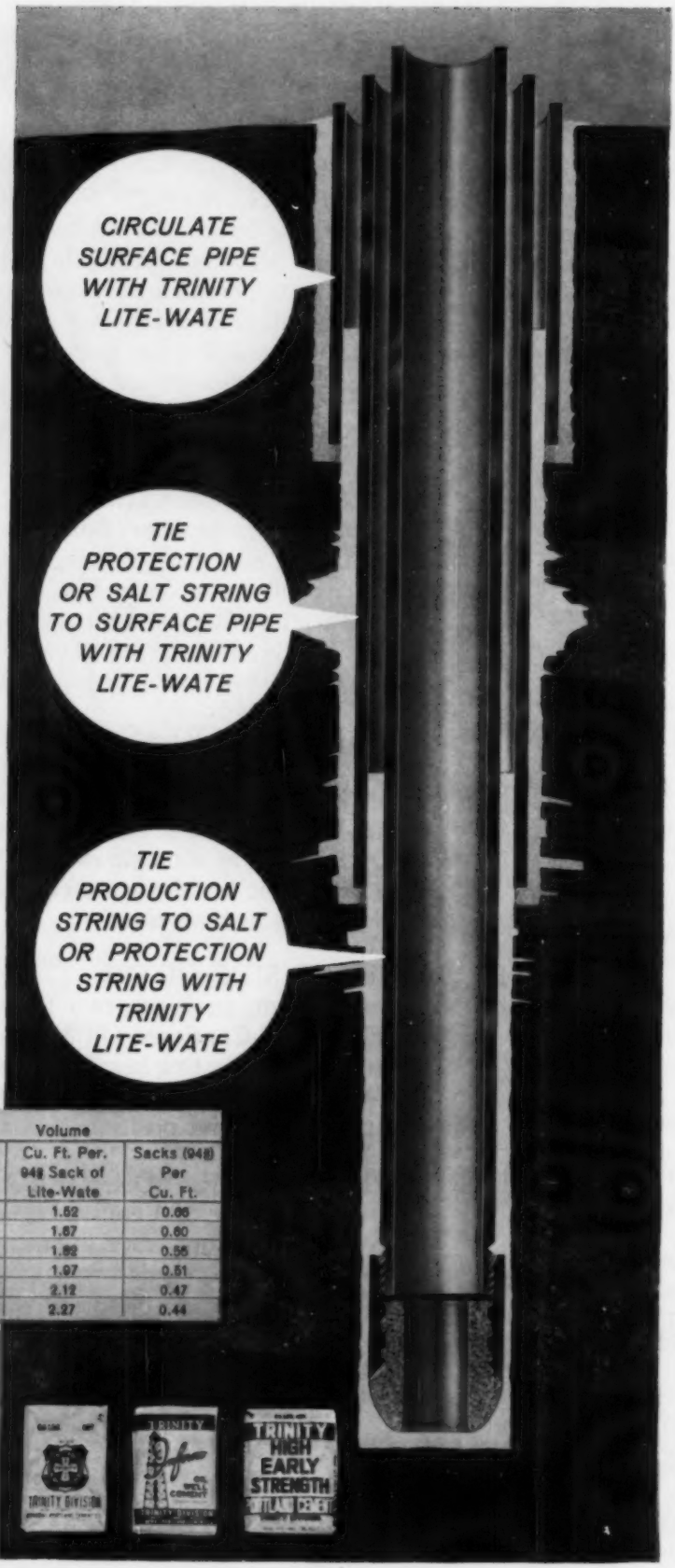
No loss to weak formations

Trinity Lite-Wate is a neat oil well cement with a low slurry density. Nothing to add but water. It derives its light weight properties entirely from the high quality raw materials from which it is made. Easy mixing, easy pumping, can be circulated with low pump pressure and without loss to weak formations. It has proved satisfactory in circulating the surface pipe, tying protection or salt string to surface pipe and tying production string to protection or salt string.

Trinity Lite-Wate has been in use for several months in such varying well conditions as found in West Texas, Oklahoma, East Texas, Louisiana, Gulf Offshore and New Mexico, it has produced returns in *every case* where attempted.

SLURRY PROPERTIES

All slurries were mixed in accordance with procedures in API RP 10B. Slurry weight and volume were calculated on the basis of Lite-Wate specific gravity of 2.80.


CIRCULATE SURFACE PIPE WITH TRINITY LITE-WATE
TIE PROTECTION OR SALT STRING TO SURFACE PIPE WITH TRINITY LITE-WATE
TIE PRODUCTION STRING TO SALT OR PROTECTION STRING WITH TRINITY LITE-WATE
TRINITY
TRINITY HIGH EARLY STRENGTH

Mixing Water			Volume		
Per cent	Gallons Per 94# Sack of Lite-Wate	Initial Viscosity Poises	Slurry Wt. Pounds per Gallon	Cu. Ft. Per. 94# Sack of Lite-Wate	Sacks (94#) Per Cu. Ft.
66	7.33	13	13.66	1.52	0.66
76	8.46	6	13.19	1.67	0.60
86	9.58	4	12.77	1.82	0.55
96	10.72	3	12.44	1.97	0.51
106	11.84	2	12.14	2.12	0.47
116	12.97	1	11.89	2.27	0.44

TRINITY

PORTLAND CEMENT DIVISION
GENERAL PORTLAND CEMENT COMPANY

GPCC

DALLAS·FT.WORTH·HOUSTON

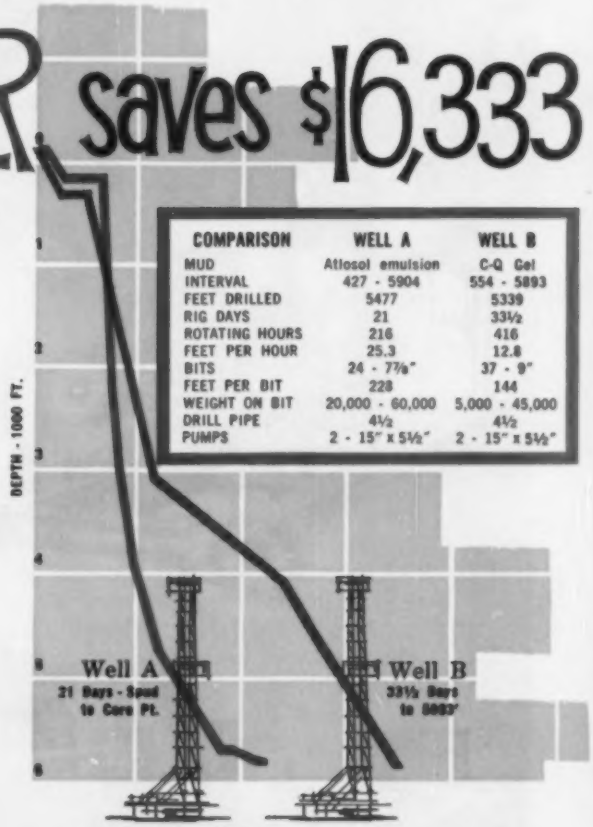
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Faster Drilling-Fewer Bits

ATLAS EMULSIFIER saves $16,333

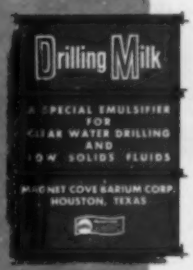
Faster drilling on Big Horn Basin Well, Big Horn County, Wyoming, cut rig time by 12½ days and required 13 fewer bits than offset Well B . . . both contractor and operator attribute savings directly to the mud program utilizing an Atlas emulsifier. Both wells were drilled with the same size equipment and under equivalent conditions. The mud program for Well A, however, was in sharp contrast to the high-solids, high-weight, high-viscosity muds generally used in this area. Acclaimed as the best-drilled well in the area to date, Well A used a low-solids oil-in-water emulsion with an Atlas emulsifier. This low-viscosity, low water-loss fluid maintained a trouble-free open hole, brought up clean cuttings and made the savings possible . . . a total of $16,333 in rig time and bit costs.

COMPARISON	WELL A	WELL B
MUD	Atlosol emulsion	C-Q Gel
INTERVAL	427 - 5904	554 - 5893
FEET DRILLED	5477	5339
RIG DAYS	21	33½
ROTATING HOURS	216	416
FEET PER HOUR	25.3	12.8
BITS	24 - 7⅞"	37 - 9"
FEET PER BIT	228	144
WEIGHT ON BIT	20,000 - 60,000	5,000 - 45,000
DRILL PIPE	4½	4½
PUMPS	2 - 15" x 5½"	2 - 15" x 5½"



Atlas emulsifier is sold through distributors under these tradenames . . . each is the product of Aquaness Department, Atlas Powder Company:

TRIMULSO®
Distributed by Baroid Division, National Lead Company
Registered trademark Baroid Division, National Lead Company



DRILLING MILK
Distributed by Magnet Cove Barium Corporation
Registered trademark Magnet Cove Barium Corporation

ATLOSOL
Distributed by Milwhite Mud Sales Company and other selected mud companies
Registered trademark Atlas Powder Company

ATLAS EMULSIFIERS IMPROVE A GOOD DRILLING FLUID
Because Atlas oil-in-water emulsion muds provide better oil action, they improve hole conditions, extend bit life, and increase penetration rates.

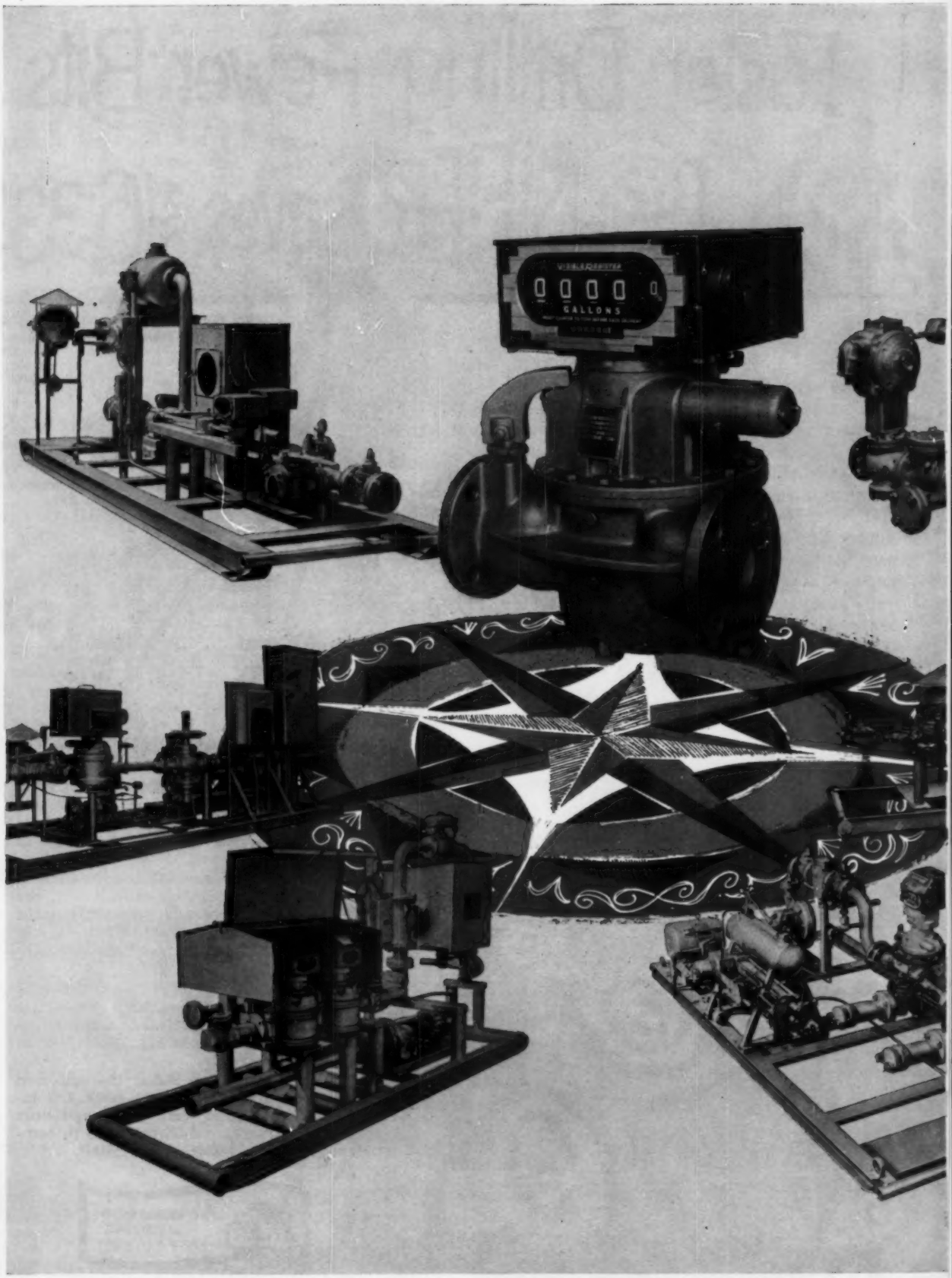
Better Hole Conditions. Atlas oil emulsion decreases torque as much as 50% . . . the hole is kept cleaner and pump pressures are correspondingly lower. There is less danger in lost-circulation and low-pressure zones.

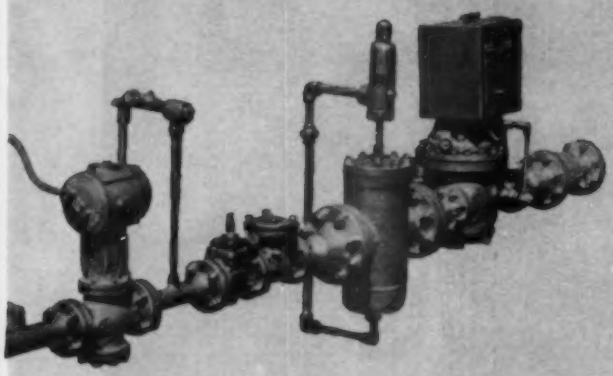
Longer Bit Life. Atlas oil emulsion prevents balling, provides better cutter and bearing lubrication. Greatly extended bit life reduces bit costs, reduces rig hours lost to trip time.

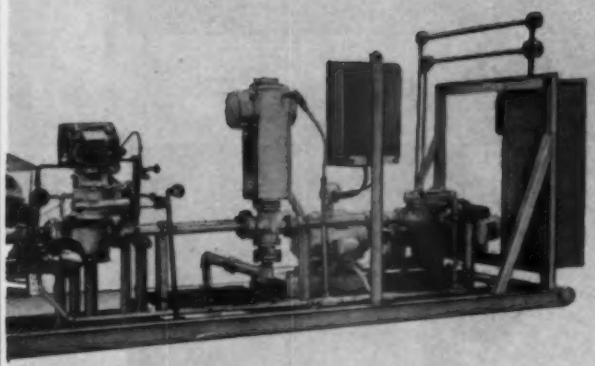
Faster Drilling Rates. Atlas oil emulsion makes more feet of hole per hour. Oil lubrication combines with improved hole condition to increase drilling rates in competent and troublesome formations.

ATLAS Aquaness CHEMICALS ATLAS POWDER COMPANY

Aquaness Department, Atlas Powder Company
P. O. Box 21072 • Houston 26, Texas


GALLONS





NO LACK OF L.A.C.T.

LEADING COMPANIES EVERYWHERE KEEP THE RECORD STRAIGHT WITH L.A.C.T. METERS BY SMITH-ERIE

It's the automatic choice at lease holdings from coast to coast — Lease Automatic Custody Transfer systems with precision metering by Smith-Erie.

As close to foolproof as modern science can make them, Smith-Erie L.A.C.T. meters afford undisputable transfer evidence for royalty owner, producer, pipeliner, etc. Economical, too! L.A.C.T. systems do away with costly lease tankage systems... reduce manpower required to hand gauge tanks.

Smith-Erie leads in L.A.C.T. as it does in metering all along the line. Pick a transfer point! Well-site... refinery... bulk plant... truck... service station — you can be sure of uninterrupted high flow and sustained accuracy with Smith-Erie meters on the job. For the complete meter story, contact your representative or write direct.

Through research ...a better way

A.O. Smith
CORPORATION
Smith-Erie Division

Factory: 1602 Wagner Ave., Erie, Pennsylvania. Offices: Atlanta 5, Ga.; Chicago 3, Ill.; Houston 2, Texas; Los Angeles 22, Calif.; New York 17, N.Y.; Newark, Calif.; Tulsa, Okla. Canada: Toronto 12, Vancouver 1. A. O. Smith INTERNATIONAL S.A., Milwaukee 1, Wis., U.S.A.

CARRY YOUR WELL SWABBING "RIG" UNDER YOUR ARM!

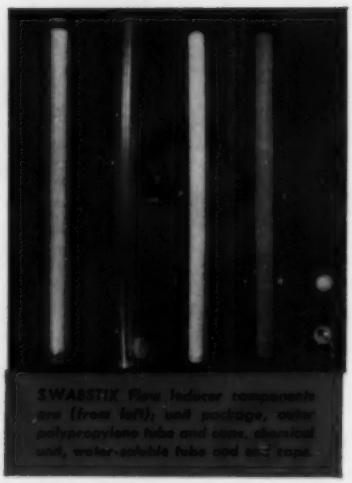
SWABSTIX Flow Inducers (each 1¼" in diameter and 2½" long, packaged six to a carton) down the well tubing.

New Swabstix *Flow Inducers*

SWABSTIX* Flow Inducers, unique new products developed through Tretolite research, now make it possible to restore oil flow in fluid-logged wells through *chemical* swabbing. Remarkably easy to transport and use, they offer obvious advantages over conventional mechanical rigs, particularly when wells are difficult to reach, such as in offshore or bayou locations.

Enough SWABSTIX Flow Inducers for a complete well treatment can be carried anywhere by one man. Swabbing requires no additional help, no special tools or equipment. No other method is as fast and convenient.

Each SWABSTIX Flow Inducer unit consists of a water-soluble, oil-insoluble plastic cylinder filled with a powdered chemical. The cylinder is dropped down the fluid-logged well tubing and remains intact while traveling through the oil column. Upon reaching the water phase, the stick dissolves. The released chemical rapidly generates gas by reaction with water. This gas increases in volume and reduces the density of the well fluids. As the gas expands and moves toward the surface where pressures are lower, flow is induced.



SWABSTIX Flow Inducer components are (from left), unit package, outer polypropylene tube and caps, chemical unit, water-soluble tube and end caps.

Ask the Man in the Red Car *to explain more about the use of this new Tretolite product, or write for the* SWABSTIX *brochure just published.*

**Trademark of Petrolite Corporation*

PETROLITE
CORPORATION

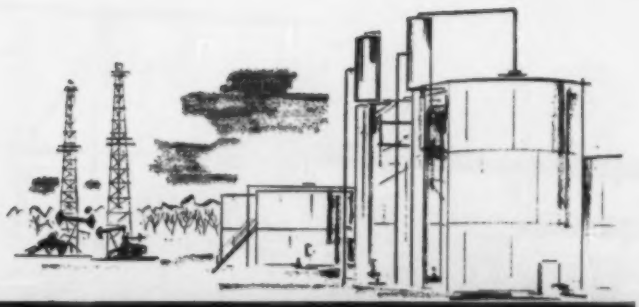
TRETOLITE COMPANY
DIVISIONS
[illegible]

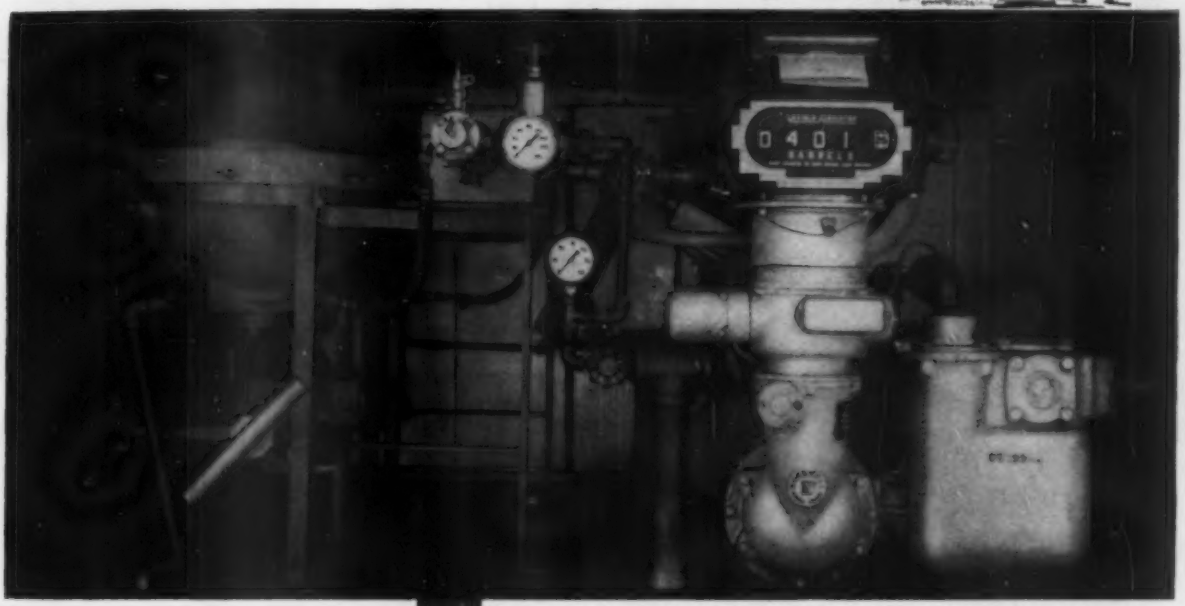
SUBSIDIARY AND AFFILIATED COMPANIES
CANADA, Edmonton, Alberta • ENGLAND, London
GERMANY, Frankfurt, a. M. • VENEZUELA, Caracas

REPRESENTATIVES
ARGENTINA, Buenos Aires • BRAZIL, Rio de Janeiro • COLOMBIA, Bogota
ITALY, Rome • JAPAN, Tokyo • KUWAIT, Kuwait • MEXICO, Mexico, D. F.
NETHERLANDS, The Hague • PERU, Talara • TRINIDAD, Port of Spain

99-60-2

Out on the lease...





Two Rockwell Rotocycle T-70 meters mounted back to back in a cabinet on lease in Wyoming. Meters are fitted with air eliminators, temperature compensators, impulse contactors and ticket printers.

You'll benefit from the accuracy and convenience of Rockwell Rotocycle meters

This model 2 BH Rockwell Rotocycle meter measures oil from tank battery into a pipeline at Big Muddy field near Casper, Wyoming.

On ACT and LACT services, Rockwell Rotocycle meter systems will save you time, trouble and money. Rotocycle meters have an all-revolving measuring mechanism. They turn freely on anti-friction bearings without metal-to-metal contact. Rockwell air eliminators remove all entrapped vapors. Automatic temperature compensators assure measurement at a uniform base temperature. Ticket printing registers verify quantities, simplify accounting. Electric impulse contactors actuate remote counters and/or control accessories such as solenoid valves for automatic shut-off.

The advantages in the Rockwell system include (1) the highest degree of accuracy and conservation control (2) lower operating costs and (3) reliable records upon which to base transfer and tax payments. For details write Rockwell Manufacturing Co., Dept. 123L, Pittsburg 8, Pa. In Canada: Rockwell Manufacturing Co. of Canada, Ltd., Box 420, Guelph, Ont.

OIL FIELD METER SYSTEMS

another fine product by

ROCKWELL

Macks are the muscles of the oil fields. Here one of Bill Hodges' B-61 Model Macks places heavy machinery at drill site. Rutted, muddy footing is taken in stride because **Mack oil field trucks are built for oil field work.**

MACK
for over 7 straight years
NO.1
by far in sales of diesel trucks

Oil field trucker Bill Hodges says

"We use the best equipment we can buy"

"It doesn't pay to fool around with 'bargain' equipment in the oil fields," says Bill Hodges, head man at the Oklahoma City trucking company that bears his name. "Hundreds of rig moves have taught us the value of quality equipment. From trucks on down, every piece of equipment we use is one grade – the best."

Bill Hodges Truck Co. operates dozens of Macks . . . has units to handle loads up to 160,000 lbs. Macks have the capacity, the power, the rugged strength and flexibility to deliver rigs, equipment and machinery where they're wanted, when they're wanted. Mack-built Thermodyne® engines – gasoline or diesel – are unexcelled for long life, dependability and fuel economy. Mack-built transmissions are available up to 20 speeds, and are built to accommodate power takeoff units. On 6-wheel units, Mack's Balanced Bogie with Power Divider allows Mack trucks to move the heaviest loads over the roughest oil-field terrain by automatically applying controlled torque to the axle with greater traction.

In oil field work where more is demanded of a truck, you'll get more out of a Mack. Your Mack branch or distributor will be glad to show you why. Mack Trucks, Inc., Plainfield, New Jersey. Mack Trucks of Canada, Ltd., Toronto, Ontario. 7714

MACK
FIRST NAME FOR
TRUCKS

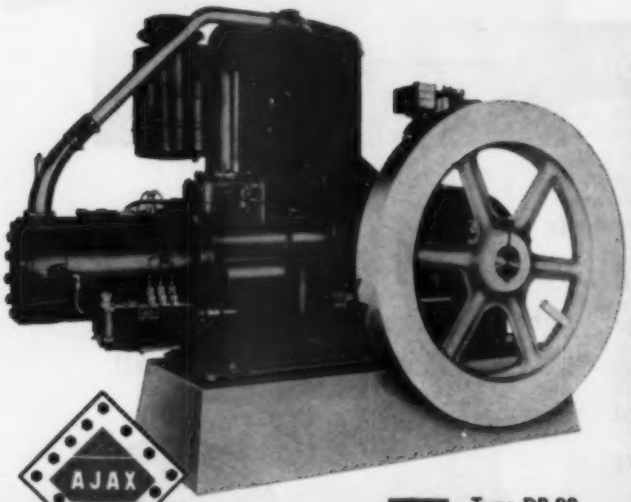
WHEN YOU INVEST IN AN AJAX PRODUCT YOU CAN BE CERTAIN IT HAS BEEN PROVED IN ENGINEERING AND PERFORMANCE. YOU ARE NOT A PART OF THE MANUFACTURER'S "EXPERIMENTAL" PROGRAM.

Shown below (left) one of the new DP-80 Ajax long service engines and on the right the TPBL TP-5000 Ajax pump, 5" stroke, Type TPBL 5375 rated at 112 HP . . .

Send for the new brochure on the new Ajax Engines and Single Cylinder Engine-Compressors . . .

Now as always — a full dollar's proven value in every Ajax product — all ways.

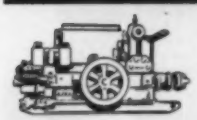
Are you a "GUINEA PIG" Customer?



Type DP-80

TPBL-5375 Pump

ALWAYS A FULL DOLLAR'S VALUE IN AN AJAX PRODUCT



AJAX . . . also builders of COMPRESSORS —— PUMPS

AJAX IRON WORKS CORRY, PENNSYLVANIA

Oil Field Distributors

- The National Supply Co. — Pittsburgh, Pennsylvania
- Bethlehem Steel Co. — Supply Division, Tulsa, Oklahoma
- Mid-Continent Supply Co. — Fort Worth, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Visco CUTS EMULSION-BREAKER COSTS

. . . on large leases

. . . or small

Visco's emulsion-breaking economy goes clear across the board . . . big operations or small . . . tough- or easy-to-break emulsions. It makes no difference whether you need a drum of emulsion-breaker a day or one every six months—you can be certain your Visco Field Service Man will find the right formula to give you dry oil at lowest cost. For fast action, call Houston, JAckson 8-2495.

VISCO PRODUCTS COMPANY
INCORPORATED
1020 Holcombe Blvd. • Houston 25, Texas

Visco® CONSISTENTLY EFFICIENT OIL FIELD CHEMICALS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

SHORT COMPACT RUGGED

GUIBERSON'S SHORTY TENSION PACKER *for* WATER FLOODING

Here is a rugged, low-cost retrievable tension packer that's short and easy to handle. Uncomplicated and functional in design, it's easy to set, space out and spot . . tension set by pulling on tubing string. And Guiberson's shorty tension packer is priced to cut your costs . . designed especially for water flood injection wells.

SAFETY JOINT COUPLING: right hand release 8 round thread for added safety.
ANCHOR CAGE: one piece malleable iron.
MANDREL: full opening heavy one piece seamless steel tubing.
LATCH: dependable J-slot mechanism, shock-absorber equipped, independent of safety joint operation.
FRICTION PADS: heat-treated pearlitic malleable iron.
SLIPS: heat-treated alloy steel.
HEADS: drillable cast iron.
RUBBER: specially compounded to withstand the most rugged oilfield use at high pressures and temperatures—built-in ability to return to original shape.
THIMBLE: drillable cast iron.
SAFETY RELEASE NUT: predetermined tension load at packer strips out, leaving safety nut, thimble, rubber and head—all drillable.

Sold by Oil Field Supply Stores Everywhere

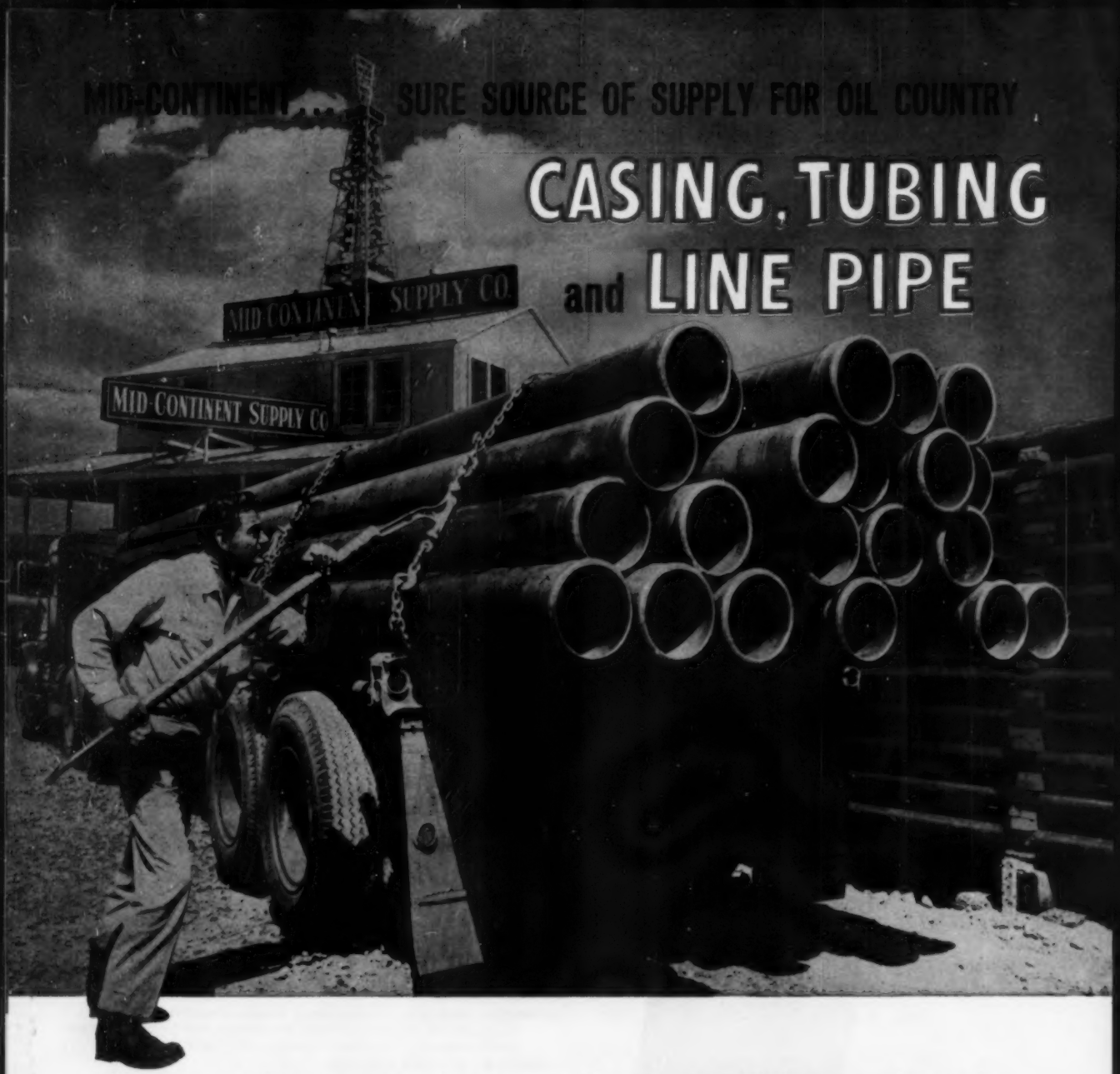
BETTER BE SAFE THAN SORRY
GUIBERSON

THE
GUIBERSON
CORPORATION

ESTABLISHED 1939

DALLAS, TEXAS U. S. A.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD


MID-CONTINENT ... SURE SOURCE OF SUPPLY FOR OIL COUNTRY
CASING, TUBING
and LINE PIPE
MID-CONTINENT SUPPLY CO.
MID-CONTINENT SUPPLY CO

Whenever or wherever you need casing, tubing or line pipe, count on your nearby "supermarket for the oil industry" to supply your exact needs promptly from large stocks of tubular items. High-strength casing and tubing are also available from Mid-Continent in a complete range of sizes, all quality-controlled in manufacture for uniformity, and for long and dependable service. Call your Mid-Continent representative today. Let him explain all the advantages of this sure source of supply — around the clock . . . around the world — for top-quality tubular goods.

GP1-0

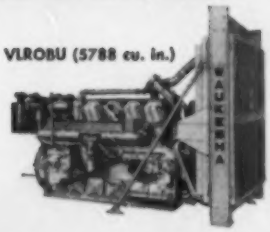
MID-CONTINENT SUPPLY CO.

THE WORLD'S LARGEST INDEPENDENT OIL FIELD SUPPLY COMPANY

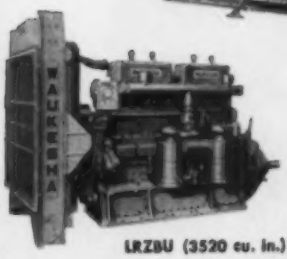
Mid-Continent Building, Fort Worth, Texas • Export Division: 45 Rockefeller Plaza, New York 20, N.Y. Cable: MIDCUMPORT NYK

When you need a gas engine... buy a

WAUKESHA "designed for gas" ENGINE



VLROBU (5788 cu. in.)

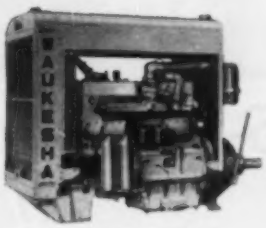


LRZBU (3520 cu. in.)

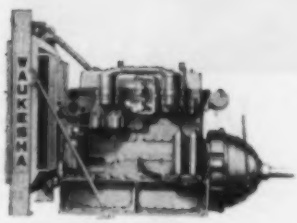
Need a gas engine? How can you pick a gas engine that's "tailor-made" for your needs? Get a Waukesha *designed-for-gas* engine! Then you can be sure—before you buy. Why? The Waukesha gas engine line is *complete*. You can get *exactly* the right engine to meet your needs. The Waukesha combination of *designed-for-gas—and* built-for-gas construction features, and first-quality materials—with low fuel and lubrication costs—is the result of over fifty years' experience in building fine engines. In oil fields all over the world *Waukesha* is the word and the buy-word for *dependable* full rated horsepower on gas fuel.

WAUKESHA MOTOR COMPANY
Waukesha, Wisconsin
New York • Tulsa • Los Angeles
Factories: Waukesha, Wisconsin and Clinton, Iowa

LOOK at this complete line of WAUKESHA *designed-for-gas* engines. Send for literature.



WAKCU (1197 cu. in.)



NKRBU (1905 cu. in.)

496-R

The ratings below are for standard engines without power consuming accessories

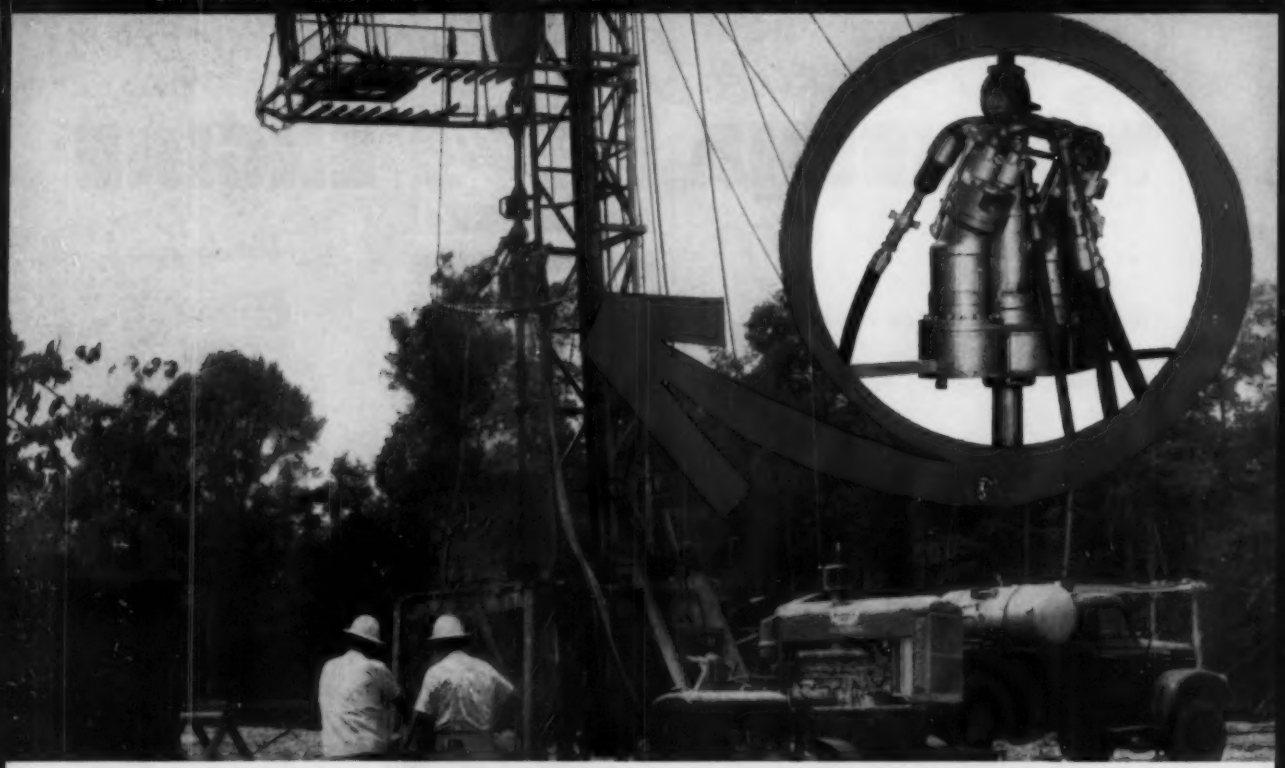
MEDIUM NATURAL GAS ENGINES					800	1000	1200	1400	1600	1800	2000	2200	2400	2600
ICK	4-A	2½x3⅛	61	36-1600	5	6	8	9	11	12	14	15	16	
FC	4-Ir	3¼x4	133	88-1200	12	16	20	23	26	28	30	31	31	31
180-GKB	4-AC	3⅜x3⅜	155	112-1400	15	20	25	30	34	37	39	42	43	
XAH	4-Ir	3⅜x4½	186	120-1400	16	22	27	32	36	39	42	42		
190-GLB	6-A	3⅜x4	265	192-1200	29	36	44	50	57	62	66	67	67	
195-GL	6-A	4 x4	302	214-1200	32	40	49	57	63	68	72	75	76	
195-GK	6-A	4½x4	320	217-1400	32	40	49	58	66	74	80	87	93	
135-GZ	6-A	4⅜x5	451	315-1200	48	60	72	83	93	103	112	118	122	
135-GZ	6-AV	4⅜x5	451	315-1200	48	60	72	83	93	103	112	118	122	
140-GZ	6-A	4½x5½	554	395-1000	60	75	90	104	116	127	136	144	149	
140-GZ	6-AV	4½x5½	554	395-1000	60	75	90	104	116	127	136	144	149	
140-GZ	6-AV†	4½x5½	554	453-800	69	86	102	117	132	145	157	167	175	
145-GZ	6-A	5⅜x6	817	597-800	91	113	135	155	174	191	205	219	230	
145-GZ	6-AV	5⅜x6	817	597-800	91	113	135	155	174	191	205	219	230	
145-GZ	6-AV†	5⅜x6	817	646-1000	98	123	147	170	193	214	233	249	264	
WAKC	6-AV	6¼x6½	1197	900-800	137	171	204	236	264	283				
WAKC	6-AV†	6¼x6½	1197	1038-800	158	193	226	258	288	315				

LARGE NATURAL GAS ENGINES					600	700	800	900	1000	1100	1200
NKRB	6-ACV	7 x8¼	1905	1505-600	172	197	220	244	266	286	306
NKRB	6-ACV†	7 x8¼	1905	1600-600	183	211	238	265	288	313	334
LRORB	6-ACV	8½x8½	2894	2270-800	252	300	346	385	420	445	464
LRORB	6-ACV†	8½x8½	2894	2341-800	260	310	357	402	443	478	508
LRZB	6-ACV	9⅜x8½	3250	2700-800	305	357	409	450	485	515	537
LRZB	6-ACV†	9⅜x8½	3250	2850-800	322	378	434	486	533	575	610
VLROB	12-ACV	8½x8½	5788	4590-600	524	601	672	743	807	859	890
VLROB	12-ACV†	8½x8½	5788	4985-700	562	665	753	835	911	978	1027

*FEATURES: 4, 6, 12—No. Cylinders; A—Aluminum Pistons; C—Counterbalanced; Ir—Cast Iron Pistons; V—Vibration Dampener.
†Special high compression ratios for higher horsepower and better economy to be fueled with dry methane type gas having a high heat value of 1150 BTU/cu. ft. or less.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW from Wilson Supply . . .



Wilson PS-70 Power Swivel has power to "burn" . . .

A new and better power swivel that delivers 4000 ft. lbs. (torque) at speeds of 0 to 100 RPM

The new Wilson Power Swivel was field-engineered to give operators top performance for . . . workover operations, deepening holes with small diameter pipe, shallow drilling, drilling out obstructions in casing, drill pipe and tubing. It has passed all field tests with flying colors.

Operators have found the Wilson PS-70 Power Swivel is easy to hook up, fast to install in working position and makes connections easily. The Swivel is hydraulic for instant torque, sensitive drilling control. It delivers 4000 ft. lbs. at speeds of 0 to 100 rpm. The unit is capable of handling 70,000 lbs. at 100 rpm and has a static load capacity of 140,000 lbs.

This packaged and unitized Wilson Hydraulic Power Swivel can be purchased or is available on rental basis. For complete information, write for new bulletin or call your nearest Wilson Supply representative.

The power package of the Wilson PS-70 Hydraulic Power Swivel is a piston-type pump, delivers 43 gal. of fluid at 2500 psi. Prime mover is rated at 87 hp.

(Inset):
Wilson PS-70 Hydraulic Power Swivel has two piston-type hydraulic motors for instant torque . . . sensitive power control

MAIN OFFICE and WAREHOUSE • 1301 CONTI STREET • HOUSTON, TEXAS
INTERNATIONAL DIVISION • 9 ROCKEFELLER PLAZA • NEW YORK 20, NEW YORK

WILSON SUPPLY CO
HOUSTON TEXAS

SALES OFFICES — DALLAS, SHREVEPORT, SAN ANTONIO, TULSA, NEW ORLEANS, LAKE CHARLES, MIDLAND, LAFAYETTE, CORPUS CHRISTI, FORT WORTH.

6026

Another FRANKS First

The advanced triangular TRI▲SCOPE DERRICK!

Replaces the Double Pole Mast where it is desirable to pull doubles for rod and tubing work.

HANG RODS • RACK PIPE

Greater speed with features such as automatically positioning rod and stacking boards. Top section automatically locks into position.

GREATER STRENGTH

Triangular construction gives greater strength with less weight. Rated 100,000# with 2-to-1 safety factor. 90′ derrick.

LESS GUYING

Minimum guying required for wind protection only. Rigs up faster than clumsy 87 ft. double pole.

HYDRAULICALLY RAISED POWER EXTENDED

Single hydraulic ram raises mast. Excellent visibility adds to many other safety features.

Call your Franks representative for the exciting details, or write for specifications folder.

WELL SERVICING AND DRILLING UNITS

FRANKS

PAMPA, TEXAS

CABOT

CABOT CORPORATION
MACHINERY DIVISION

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

TUBINGLESS COMPLETIONS

Baker has developed a complete new line of products for completions using tubing as small-diameter casing.

The picture shows some of these new products. The complete line very nearly parallels the entire Baker line of conventional-size products.

The line includes: Primary Cementing Equipment (shoes, collars, centralizers, scratchers, turbulizers); Remedial and Stimulation Tools (treating packers; both retrievable and drillable bridge plugs); Production Tools (retrievable and drillable production packers; casing pump packers, tubing anchors).

Many of these new Baker Products are not yet available in quantity, nor in all areas.

Tubingless Completions are becoming more numerous. Our own engineering and development programs continue as Baker keeps alert to the trends—ready to provide the practical and dependable new tools that will further improve tubingless completion methods and techniques.

WE INVITE YOUR INQUIRIES
Please ask your Baker Man for Technical Bulletin 378, or write to Baker Oil Tools, Inc., Box 2274, Terminal Annex, Los Angeles 54, California

BAKER

BAKER OIL TOOLS, INC. / HOUSTON / LOS ANGELES / NEW YORK

An economic study:

WHAT IT COSTS TO FIND U.S. OIL

H. J. STRUTH
Petroleum Consultant, Dallas, Texas

Operators spent $2.9 billion in a year seeking new reserves for highest cost per exploratory well on record . . . expenses exceeded wellhead value of production discovered.

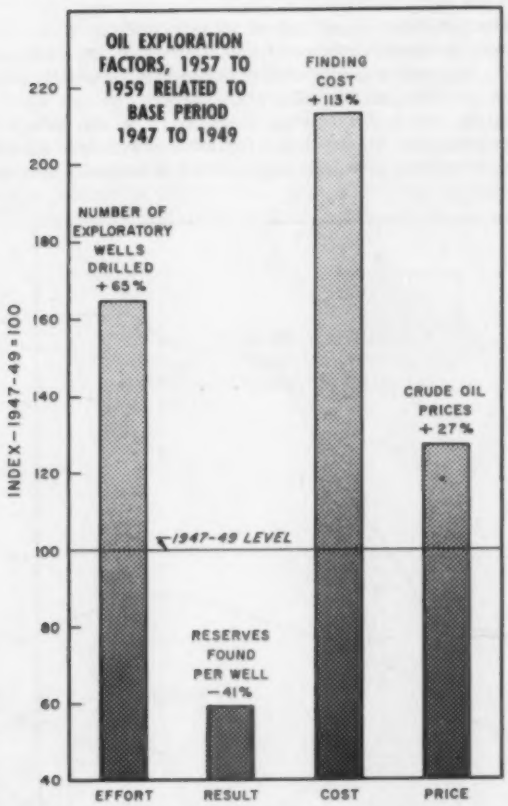


FIG. 1. In ten years, number of exploration wells drilled has increased 65% whereas reserves found per well have decreased 41%. This raises finding costs 113% while crude oil prices have risen only 27%.

Any argument by the uninitiated favoring a reduction or the elimination of the petroleum industry's depletion provision of 27½% is ineffectual against the preponderant economic and financial considerations against any such ill-advised action. Those who would deprive the petroleum industry of this long-established, fundamental concept in the national public interest should ponder well certain underlying principles which overshadow immediate government revenue considerations.

Here are a few basic premises which should be seriously considered by those who claim the oil industry's depletion provision is a "tax loophole":

1. The future supply of oil in the United States is dependent upon drilling a progressively greater number of exploratory wells, at constantly increased costs.
2. Profits of oil producers have accrued from reserves found in earlier years at much lower costs. Today's replacement costs are 113% greater than those from 1947 to 1949, while the price of crude oil is relatively only 27% higher. Meanwhile, the price of gasoline, ex-tax, has increased less than 10%, while federal and local taxes per gallon have increased 61%.
3. High costs and ill-advised threats against the industry's depletion provision have retarded exploratory drilling operations since 1956 by 15%, with total expenditures off 10.5%.
4. The oil industry is reinvesting 36.4% of its gross revenue from crude oil production in the search for new reserves, whereas the deduction for cost depletion, limited to 50% of net income, averages only 22%; not 27½%.
5. Without the incentive provided by the depletion provision, the investment of risk capital would definitely be retarded and reserves could not be maintained at adequate levels, unless the incremental funds required are obtained at public expense through higher prices for petroleum products.
6. Uninterrupted expansion of the petroleum industry, supported by an adequate depletion allowance, will provide far greater ultimate tax revenues to the federal government than would temporarily be provided by a reduction, or even the elimination of the depletion allowance. To no better purpose could the sum involved by cost depletion be dedicated.

Mr. Struth has devoted years of study in developing factual data on oil-finding costs in the United States. In fact, his first article on this subject was originally published in the PETROLEUM ENGINEER in January, 1943. This latest study appears to provide a sound case for depletion.

— Editor.

Oil Search Increasingly Expensive

The search for new oil reserves in the United States during the year 1959 involved expenditures exceeding $2.3 billion, attended by the highest cost per well ($115,476) on record. In the last three years, the oil industry's finding-cost of petroleum liquids averaged about $1.18 per bbl, compared with an average of 55.4 cents during 1947 to 1949.

Relatively, the cost of finding a barrel of oil is 113% greater, while the total cost of an average exploratory well has increased 28%. The cost of drilling the average exploratory well in 1959 was $70,206, but the additional costs of leases, geological, geophysical and overhead amounted to $45,270 per well.

Last year favorable. Preliminary cost data for the year 1959 indicates a favorable reduction in initial oil-finding costs, due to a somewhat greater volume of oil discovered. Initial discoveries last year amounted to 2.58 billion bbl, compared with 2.21 billion bbl found in 1958. However, the 1959 volume marked a decline from the rate of discovery in 1956, and was about 530 million bbl less than the quantity found in 1951.

The average cost of a barrel of all liquids found in 1959 was $1.062, compared with $1.17 in 1958 and $1.332 in 1957. The cost of finding a barrel of oil in new fields in 1959 averaged about $2.77, compared with $3.25 in 1958 and an average in the last five years of $2.70 per bbl. While some 700 more exploratory wells were drilled in 1959 than in 1958, the 20,274 such wells drilled represented a decline of 3326 wells from the number drilled in 1956.

Exploration increases but reserves decline. Analysis of the oil industry's exploration costs, values and physical factors of the last 3 years, related to the base period 1947 to 1949, indicates that exploratory effort has increased 65% while results as measured by reserves found per well have declined 41%. Meanwhile, oil-finding costs have increased 113%, whereas the price of crude oil has been advanced only 27%. Despite these adverse circumstances, the oil industry has managed during this period to increase the nation's underground reserves by 39%, after providing for a gain in production of 33%. From any viewpoint, it is strikingly evident that the maintenance of the nation's oil reserves at adequate, safe levels is fraught with increasingly greater risks of venture capital, as a result of spiraling costs and the need for progressively more and deeper wells.

Greater ratio of dry holes. The hazards attending the search for oil reserves in the United States are forcefully illustrated by the ascending dry hole ratios and the descending discovery ratios per exploratory dollar. Since the period from 1936 to 1938, the number of dry holes drilled per million bbl of oil found has increased from 3.20 to 8.45. Correspondingly, the quantity of new reserves found per exploratory dollar spent has declined from 8.90 bbl to less than one bbl. Meanwhile, exploration expenditures have shown an 11-fold increase, and the cost per exploratory well has more than trebled.

The achievements of the oil industry, despite these conditions, demonstrate beyond any doubt that the adequacy of the nation's future oil supply depends in no small degree upon an adequate depletion allowance.

In the search for new oil fields in 1959, the industry's experience was 10 dry holes for each new field discovery well. At today's costs, this means that it is necessary to spend

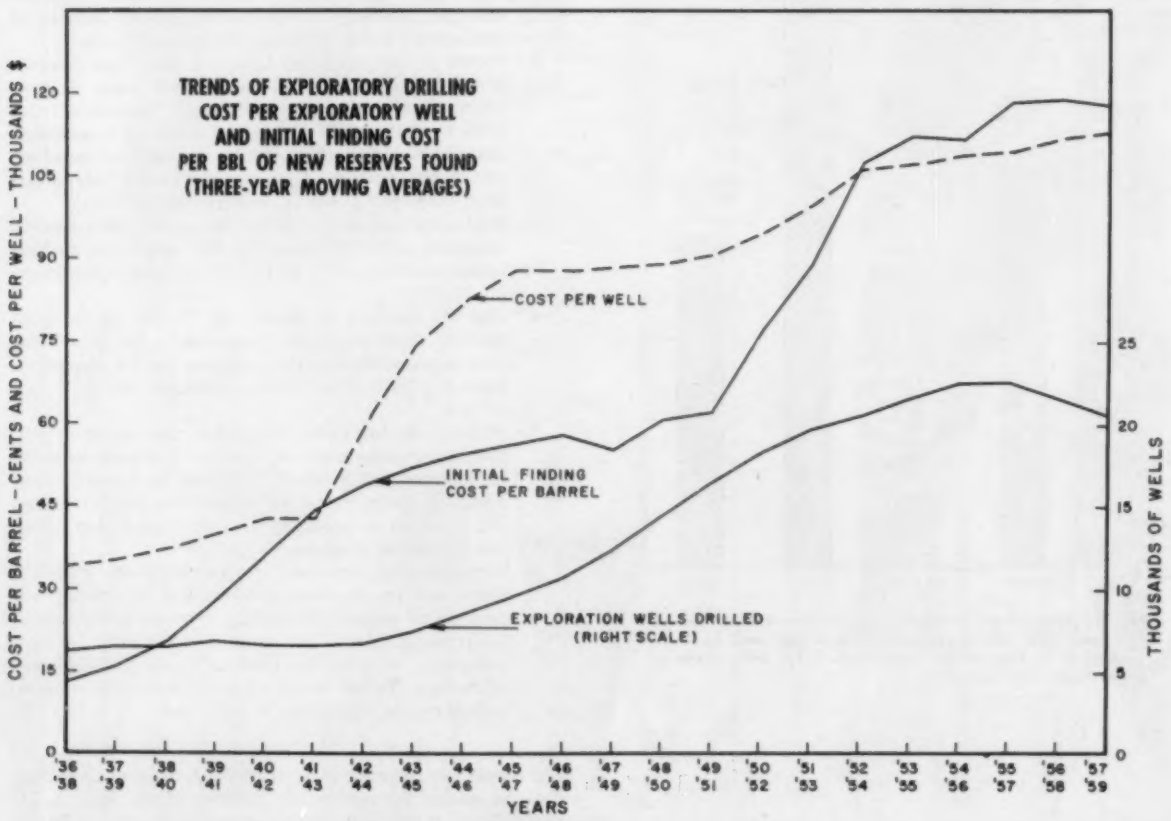


FIG. 2. Cost per well of finding oil has steadily increased, reaching an all-time peak in 1959. Initial finding cost per bbl dropped slightly during last three years, however, due to greater reserves found. Drop-off in exploration wells drilled since peak reached in 1957 reflects high drilling costs with low well-head value of oil found.

the sum of $1,462,600 to locate one new field.

While the average cost of finding a barrel of oil in new fields is $2.77, this cost does not include the subsequent cost of developing such fields, nor does it include the ultimate cost of producing the oil found in each new reservoir. Many additional dry holes are necessarily drilled in developing every new oil field discovery, which involve costs of $90,000 to $100,000 per hole drilled. Such development embraces a period of from 7 to 8 years after a new field is discovered.

Combined expenditures for oil. Exploration expenditures represent approximately one-third of the oil industry's combined expenditures involved in finding, developing and producing petroleum liquids.

On this premise, it is evident that the combined expenditures of the drilling and production branch of the oil industry in 1959 aggregated about $7,023 million. This exceeds the total market value of crude oil in 1959, which amounted to $6,426 million after payment of royalties to landowners.

This expenditure figure does not include the costs of drilling natural gas wells and the production of natural gas. It does include the cost of all dry holes drilled, however, some of which are no doubt related to gas exploration and development.

It is difficult to determine separately the number of dry holes drilled in the search for natural gas reserves, since the discoveries of oil and gas cannot reasonably be predetermined, and some wells produce both oil and gas.

Production cost greater than wellhead value. For each net barrel of crude oil produced in 1959, the U. S. oil industry spent $3.19, compared with an average wellhead value of $2.92 per bbl. Related to production, an approximate breakdown of this cost included exploration, $1.07; development, $1.21; and lifting and overhead cost, $.91.

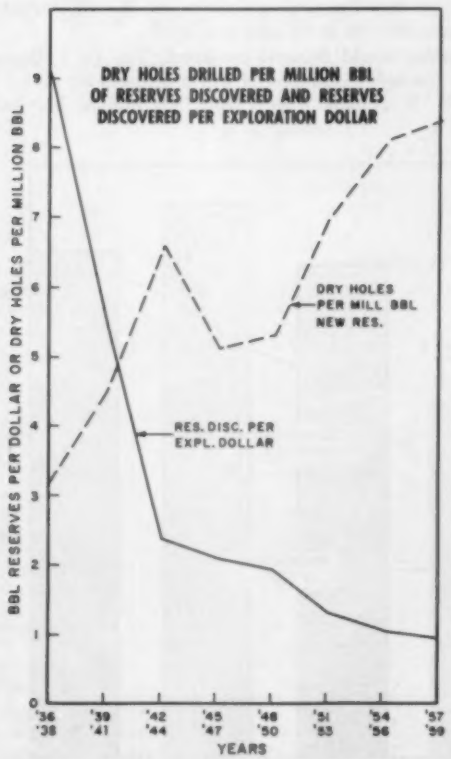


FIG. 3. Dry holes drilled for each million bbl of oil discovered have continually increased since period from 1945 to 1947. This resulted in continually less reserves discovered for each exploration dollar.

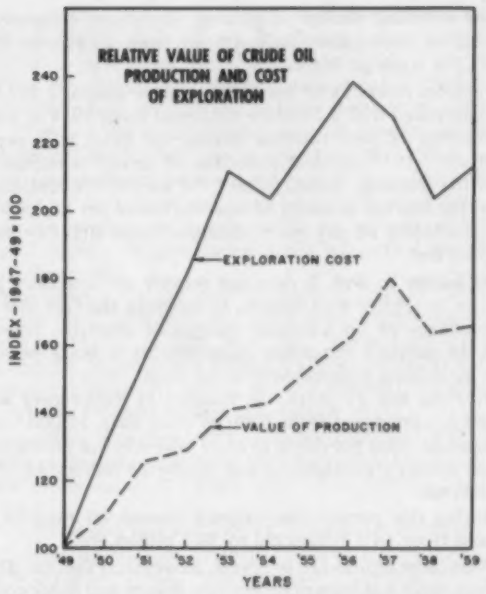


FIG. 4. Comparison of exploration costs to value of production discovered shows that these costs now comprise 36.4% of net value of production.

These indices leave no doubt that the oil producer is confronted with a serious cost-price squeeze. The only reason there is any profit in producing crude oil is because much of the oil produced today was found in earlier years, when unit finding and development costs were much lower.

The facts clearly indicate that replacement costs have more than doubled in the last 10 years, which means that any margin of profit on today's production represents the difference between present high-cost reserves and previously-discovered low-cost reserves.

The alarming fact is that oil-replacement costs are rapidly diminishing the producer's margin, which must ultimately provide less risk capital for exploration. This situation could become even more serious if such funds are impaired by an inadequate depletion allowance.

Growing petroleum requirements. Any intelligent appraisal of the nation's growing requirements for petroleum and its products should convince even the uninitiated that there can be no compromise on issues which are detrimental to the continued search for both oil and gas reserves.

Oil was a lot easier to find during World War I years, when Congress realizing its importance to the nation granted the statutory depletion provision. If this provision was held necessary then in the national interest, it is even more necessary today, since oil is harder to find and far more costly. As a matter of fact, the depletion allowance of World War I days has been outmoded by subsequent events. More realistically, the rate applicable under today's conditions should be at least 35% instead of 27½%.

In the last 13 years, the oil industry has plowed back an average of 36.7% of its gross income from crude oil for exploration. In several intervening years such expenditures have exceeded 40% of the producer's gross income.

Risk capital limited. In the last three years, the oil industry has been confronted with shrinking profit margins, largely as a result of excessive oil supplies throughout the world and the necessity to curtail domestic production. Reduced income and renewed threats against the industry's depletion allowance have prompted precautionary measures to limit investments of risk capital to minimum contractual obligations.

The resulting decline in drilling operations reduced the number of exploratory wells drilled from 23,600 in 1956 to 20,274 wells in 1959.

Reserves found in the last three years averaged 2,295,000 bbl, compared with 2,554,000 bbl found from 1954 to 1956. Discoveries of new reserves during the three year period from 1957-1959 marked a decline of nearly a billion bbl from the quantity found from 1951 to 1953. Correspondingly, the average quantity of reserves found per exploratory well, including all dry holes, declined from 131,000 bbl to 112,000 bbl.

Oil harder to find. It does not require extra-sensory perception, or agility with figures, to establish the fact that the maintenance of an adequate margin of available reserves over the nation's expanding requirements is made possible only by drilling progressively more wells.

Over the last 25 years, the number of exploratory wells drilled has increased from 6000 to more than 22,000 wells. Meanwhile, after providing over 49 billion bbl of production, the oil industry managed to add nearly 24 billion bbl of oil to reserves.

During this period, the nation's proved oil reserves increased from 14.5 billion bbl to 38.3 billion bbl.

What these figures fail to reveal, however, is that the depth of these wells has been progressively deeper and more costly, and that the success ratio in the search for new reserves has shown a declining trend.

A concrete example of the need for drilling an increasingly greater number of wells to maintain a safe margin of reserves over production is cited by the following comparative data:

Three year totals	1947 to 1949	1957 to 1959
Exploratory wells drilled	37,275	61,383
Exploratory expenditures (million $)	3,294	6,939
Total reserves added (million bbl)	10,557	10,398
Reserves added per well (thousand bbl)	283	169
Production (million bbl)	6,154	8,551
Net increase in reserves (million bbl)	4,403	1,847
Net increase per well (thousand bbl)	117	30
Production, percent of reserves added	58	82

EXPLORATION COSTS, VALUES AND PHYSICAL FACTORS

(1957-59 Related to Base Period 1947-49)

Annual averages	1947 to 1949	1957 to 1959	Index 1947 to 1949=100
Exploratory wells drilled	12,425	20,461	165
Exploration expenditures (million $)	1,098	2,313	210
Initial reserves found (million bbl)	2,320	2,295	99
Finding cost per bbl	$.554	$1.179	213
Price of crude per bbl	$2.36	$3.00	127
Crude oil production (million bbl)	1,906	2,546	133
Net value of production (million $)	3,846	6,544	170
Reserves found per expl. well (thous. bbl)	187	112	60
Reserves found per expl. dollar (bbl)	8.90	0.99	11
Exploratory wells per million bbl found	5.36	8.91	168
Dry holes per million bbl found	4.92	8.46	172
Drilling and equipment cost per well	$47,785	$ 69,277	145
Total cost per exploratory well	$88,402	$113,057	128
All footage drilled (million ft)	130	204	157
Average depth of all wells drilled	3,697	4,140	112
Number of producing oil wells (thousand)	441	575	130
Annual revenue per well	$10,295	$ 11,385	101
Proved reserves (million bbl)	26,672	37,048	139
Reserves per producing well (bbl)	60,480	64,431	107

Unrelenting search necessary. These relationships emphasize the urgent need for an unrelenting search for new oil reserves to prevent a future deficiency in available supply. The facts prove that this can be accomplished only by drilling progressively more wells, if tomorrow's oil needs are to be sustained by an adequate margin of proved reserves. In fact, a look into the foreseeable future reveals an imperative need for a continued upward trend in exploratory drilling operations.

Demand for oil for normal, peacetime needs will definitely be much greater in the next 15 years, which will tax the ingenuity and financial resources of the oil industry to maintain reserves at an adequate level.

Doubled world demand predicted. The U. S. Bureau of Mines foresees a doubling of world demand for oil by 1975, with U. S. demand rising from 9.6 million bbl daily in

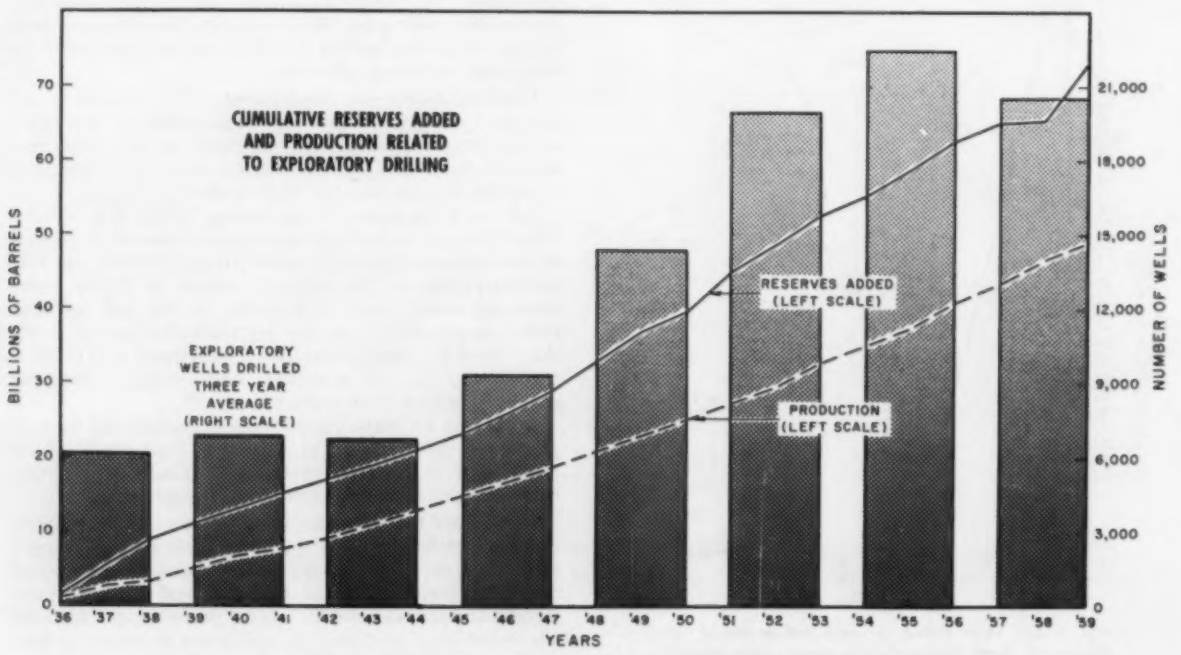


FIG. 5. Drop-off in exploratory drilling during last two years shows effects of rising costs. Increase in reserves added during 1958 resulted from greater reserves discovered per well drilled.

1959 to more than 17 million bbl daily. In order to meet this demand, the U. S. production of crude oil in 1975 will necessarily have to be increased to 4.5 billion bbl, compared with 2.9 billion bbl produced in 1959.

If the nation's oil reserves are to be maintained at 13.2 times annual production, it will be necessary to build our proved reserves to more than 59 billion bbl by 1975, compared with 38 billion bbl as of January 1, 1960. This means that some 21 billion bbl of oil will have to be added to reserves, in addition to incremental production requirements of about 55 billion bbl over the next 15 years.

To meet these requirements, it will be necessary for the oil industry to find roughly 5 billion bbl of new reserves annually. In only one year since 1936 has the industry added over 5 billion bbl of new reserves.

Future exploration expenditures. In the last 5 years, the quantity of all oil reserves added annually by new fields, extensions and revisions has averaged 3.5 billion bbl, or at the rate of 163,000 bbl per exploratory well drilled.

In order to add 5 billion bbl of reserves each year, the oil industry will have to drill 30,600 exploratory wells annually, compared with 20,274 such wells drilled in 1959.

Even at today's costs, without considering further inflation, this means that the industry's exploratory expenditures will be at least $3.5 billion annually over the next 15 years. Such expenditures in 1959 amounted to $2.3 billion.

Where reserves originate. Results of the last five years indicate that new field oil discoveries comprise about 14.5% of the total reserves added, while 85.5% is credited to extensions and revisions in previous estimates. Experience indicates that it takes seven to eight years after a new field is found to develop its ultimate potentialities.

Thus, the bulk of the reserves added today result from the development of previous, original discoveries. Over the last 25 years, the ratio of such ultimate reserves credits to original discoveries has been in the order of 5.19.

Oil field declining asset. Every new oil field discovered is a declining asset from its inception, which emphasizes the need for undiminishing efforts of oil men to offset the natural decline of productive wells with new sources of available supply.

Obviously, costs are not expected to remain stationary over the next 15 years, and experience proves that oil is becoming harder to find each year. These facts preclude and should dissuade any political action which would discourage and retard the efforts of the oil industry to maintain the nation's reserves at safe, dependable levels.

Secondary recovery costly. Another important and costly development, which extends the productive life of the nation's oil fields, is the application of secondary recovery methods.

Waterflooding and injection of gas and air in many older fields have enabled the industry to recover millions of barrels of oil which might otherwise have been lost by conventional flowing and pumping methods. These costs, which involve increasingly greater outlays of capital, are not included in the accompanying studies of exploration expenditures.

COST OF FINDING OIL IN THE UNITED STATES

(Incorporating new revisions in previous estimates and ultimate reflections of costs prior to 1959)

	Initial Res. Disc.		Revised Res. Disc.						Cost per bbl		Cost per Well	
	Gross (mill. bbl) (1)	Net (mill. bbl) (2)	Gross (mill. bbl) (3)	Net (mill. bbl) (4)	Explor. wells drilled (5)	Drilling cost (thous. $) (6)	Other charges (thous. $) (7)	Total cost (thous. $) (8)	Initial disc. (9)	Revised disc. (10)	Drilling cost (11)	Total cost (12)
1950	2,382	2,037	3,656	3,126	16,249	821,750	617,600	1,439,350	$ .706	$ .460	$50,572	$ 88,600
1951	3,101	2,651	4,124	3,537	18,760	1,018,565	721,010	1,739,575	.607	.493	54,300	92,600
1952	2,372	2,028	3,461	2,959	19,350	1,217,365	769,880	1,987,245	.980	.673	62,900	102,700
1953	2,348	2,008	3,068	3,623	21,573	1,442,150	886,434	2,328,584	1.160	.891	66,850	107,940
1954	2,436	2,083	3,195	2,732	20,879	1,366,241	884,765	2,251,006	1.095	.824	65,436	107,812
1955	2,476	2,117	3,262	2,789	22,553	1,507,055	920,909	2,427,964	1.147	.872	66,820	107,653
1956	2,750	2,351	3,365	2,877	23,600	1,593,634	1,028,174	2,621,808	1.115	.912	67,527	111,092
1957	2,095	1,791	2,498	2,136	21,550	1,482,409	904,126	2,386,535	1.332	1.121	68,790	111,117
1958	2,212	1,891	2,794	2,089	19,559	1,346,708	865,421	2,212,129	1.170	1.059	68,853	113,823
1959p	2,578	2,204	—	—	20,274	1,423,369	917,804	2,341,173	1.062	—	70,206	115,476
THREE-YEAR MOVING AVERAGES												
1936-38	1,848	1,580	2,779	2,376	6,161	75,277	132,623	207,900	.131	.106	12,218	33,744
1937-39	1,744	1,484	2,577	2,203	6,525	83,779	147,833	232,612	.157	.135	12,840	35,649
1938-40	1,441	1,225	2,108	1,819	6,607	88,836	157,153	245,989	.201	.189	13,446	37,232
1939-41	1,150	977	1,667	1,442	6,969	101,696	170,820	272,516	.279	.198	14,593	39,104
1940-42	926	792	1,354	1,441	6,750	111,350	173,520	284,870	.360	.281	16,496	42,203
1941-43	873	747	1,481	1,174	6,679	133,643	196,696	330,339	.442	.263	20,009	49,459
1942-44	961	822	1,791	1,531	6,717	174,083	228,890	402,973	.490	.278	25,917	59,993
1943-45	1,228	1,050	2,348	2,008	7,464	257,027	295,823	552,850	.527	.275	34,436	74,089
1944-46	1,486	1,271	2,650	2,266	8,364	342,140	349,543	691,683	.544	.305	40,906	82,698
1945-47	1,702	1,456	2,980	2,548	9,330	422,641	397,933	820,574	.563	.322	45,299	87,950
1946-48	1,932	1,652	3,143	2,686	10,884	501,647	453,683	955,330	.578	.355	46,090	87,774
1947-49	2,320	1,983	3,521	3,010	12,425	593,726	504,665	1,098,391	.554	.364	47,785	88,402
1948-50	2,483	2,123	3,639	3,111	14,374	706,982	569,748	1,276,730	.601	.411	49,185	88,882
1949-51	2,760	2,360	3,906	3,343	16,344	845,645	623,451	1,478,096	.626	.442	51,740	90,437
1950-52	2,618	2,238	3,747	3,207	18,120	1,019,227	702,833	1,772,060	.769	.537	56,249	95,036
1951-53	2,607	2,229	3,551	3,039	19,894	1,226,027	759,108	1,985,135	.891	.652	61,628	99,786
1952-54	2,385	2,039	3,241	2,771	20,600	1,341,918	847,026	2,188,944	1.073	.792	65,142	106,259
1953-55	2,420	2,069	3,175	2,714	21,668	1,438,482	897,336	2,335,818	1.129	.865	66,387	107,800
1954-56	2,554	2,184	3,274	2,799	22,444	1,488,976	944,616	2,433,592	1.114	.867	66,342	108,430
1955-57	2,440	2,086	3,041	2,934	22,567	1,527,699	951,069	2,478,768	1.188	.846	67,712	109,954
1956-58	2,352	2,016	2,885	2,700	21,569	1,474,250	932,573	2,406,823	1.193	.891	68,350	111,587
1957-59p	2,295	1,962	—	—	20,461	1,417,495	895,783	2,313,278	1.179	—	69,277	113,057

[p]Preliminary data
[1]New fields and extensions, excluding revisions in previous estimates which are allocated to prior discovery years
[2-4]Net working interest at 85.5%
[3]Includes allocated revisions, credited to prior years
[5]Wildcat oil wells and dry holes drilled in exploration and development
[6]Includes cost of equipment
[7]Includes leases, geological, geophysical and overhead costs
[9]Col. 8 divided by Col. 2
[10]Col. 8 divided by Col. 4
[11]Col. 6 divided by Col 5
[12]Col. 8 divided by Col. 5

COST OF FINDING OIL IN NEW FIELDS

(1959 and Prior Years)

	Number	Drilling cost	Other charges	Total cost
		Cost, thous. dollars		
Discovery wells	2,572	755,629	241,333	996,962
Dry holes drilled during search for new oil field discoveries	5,981	1,794,227	145,861	1,940,088
Total cost	8,553	2,550,856	387,194	2,938,050

COMPARATIVE UNIT COSTS

	New reserves		Cost per barrel		
	Gross (mill. bbl)	Net W.I.* (mill.bbl)	Drilling cost (thous. $)	Other charges (thous. $)	Total cost (thous. $)
1959	479	410	1.83	.94	2.77
1958	423	362	2.08	1.17	3.25
1957	545	466	1.58	.78	2.36
1956	561	480	1.68	.87	2.55
1955	544	465	1.74	.85	2.59
Average last 5 years	508	434	1.78	.92	2.70

*Net working interest.

Such operations do, however, involve the drilling of injection wells and the installation of expensive equipment. While such operations increase the ultimate recovery of oil in older fields, they are made possible only under favorable economic conditions, which include compensatory oil prices and an adequate depletion allowance.

Gas production also affected. While this study is confined primarily to oil exploration and finding costs, the impact of rising costs and the need for maintaining adequate reserves applies with equal force to the natural gas industry.

Producers of natural gas, like producers of oil, are committed to a long-range program of incremental expenditures to maintain reserves at adequate levels. In fact, gas wells are generally deeper than oil wells and reports of gas producers prove that they involve proportionately greater drilling and equipment costs.

Natural gas finding and development costs have definitely paralleled the rising costs of oil, but cost factors seem to carry little weight with the Federal Power Commission, which has placed the gas industry in a utility status. Under these conditions, it is obvious that an adequate depletion allowance is also a major factor in the gas industry, since it likewise serves as an impetus to the search for gas reserves to meet growing national requirements.

Unfortunately, the gas producer is also in a cost-price squeeze since the prices of gas at wells are regulated by those set by gas distributors under the jurisdiction of the Federal Power Commission. Wellhead gas prices, like those of oil, have not paced the rise in respective costs.

Modern Oil Industry Operates Efficiently

The early years of "boom and bust," which formerly characterized the oil industry in the minds of many, are gone forever.

Today, the oil industry is a highly efficient, competitive business which, together with natural gas, supplies over 70% of the nation's energy requirements. Today, the dependence upon oil and gas is of such magnitude and importance that it affects the welfare and progress of every individual, as well as our national security. Those who direct and carry on the progressively-expanding operations and activities of this major American industry have a direct responsibility to the public and the nation in making sure that the nation will continue to have a dependable supply of petroleum.

Progressive leaders. Under the weight of growing technical and financial problems, the U. S. petroleum industry is fortunately endowed with far-sighted, progressive leadership and highly-skilled technicians. Those who make up the human side of the petroleum industry are well aware of

U. S. PETROLEUM LIQUIDS RESERVES, DISCOVERIES AND PRODUCTION

Years of 1936 to 1959
(millions of barrels)

Year	Estimated Reserves Jan. 1 (b)	Discoveries (a) New Pools (c)	Discoveries (a) Ext. and Revisions (c)	Discoveries (a) Total Oil Added (c)	Production (d)	Net Increase (b)	Allocation of Ext. and Rev. (e)	Ultimate Credits to Orig. Disc.	Ratio Ultimate Credits to Orig. Disc.	Cumulative Initial Disc.	Cumulative Ultimate Disc.
1936	14,485	860	950	1,810	1,142	668	1,988	2,848	3.31	860	2,848
1937	15,153	940	2,850	3,790	1,328	2,462	1,878	2,818	3.00	1,800	5,666
1938	17,615	825	2,325	3,150	1,265	1,885	2,373	3,198	3.88	2,625	8,864
1939	19,500	360	2,140	2,500	1,317	1,183	2,042	2,402	6.67	2,985	11,266
1940	20,683	315	1,685	2,000	1,409	591	2,162	2,477	7.86	3,300	13,743
1941	21,274	455	1,620	2,075	1,483	592	1,907	2,362	5.19	3,755	16,105
1942	21,866	280	1,700	1,980	1,470	510	2,017	2,297	8.20	4,035	18,402
1943	22,376	345	1,265	1,610	1,594	16	2,425	2,770	8.03	4,380	21,172
1944	22,392	515	1,574	2,089	1,778	311	2,825	3,340	6.48	4,895	24,512
1945	22,703	440	1,870	2,310	1,836	474	3,212	3,652	8.30	5,335	28,164
1946	23,177	323	2,370	2,693	1,850	843	2,987	3,310	10.25	5,658	31,474
1947	24,020	505	2,211	2,716	1,988	728	3,360	3,865	7.65	6,163	35,339
1948	24,748	461	3,805	4,266	2,167	2,099	3,117	3,578	7.76	6,624	38,917
1949	26,847	983	2,592	3,575	1,999	1,576	3,067	4,050	4.12	7,607	42,967
1950	28,423	623	2,706	3,329	2,154	1,175	3,072	3,695	5.93	8,230	46,662
1951	29,598	465	4,673	5,138	2,453	2,685	2,876	3,341	7.18	8,695	50,003
1952	32,283	578	2,728	3,306	2,513	793	2,849	3,427	5.93	9,273	53,430
1953	33,076	688	3,352	4,040	2,596	1,444	2,323	3,011	4.37	9,961	56,441
1954	34,520	672	2,308	2,980	2,568	412	2,216	2,888	4.32	10,663	59,329
1955	34,932	544	2,841	3,385	2,766	619	2,030	2,574	4.73	11,177	61,903
1956	35,551	561	3,223	3,784	2,910	874	1,473	2,034	3.62	11,738	63,937
1957	36,425	545	2,017	2,562	2,912	—350	1,286	1,831	3.36	12,283	65,768
1958	36,075	423	3,043	3,466	2,744	722	878	1,301	3.08	12,706	67,069
1959 (p)	36,797	479	3,891	4,370	2,895	1,475	990*	1,440*	3.01	13,185	68,509
1960 (p)	38,272(f)										
Totals	—	13,185	59,739	72,924	49,137	23,787	55,353	68,509	5.19	—	—

[a] As reported by joint Committee on Reserves of API and AGA
[b] Reserves Committee estimates adjusted to reflect differences between estimated and actual production reported by Bureau of Mines
[c] Includes natural gas liquids, which were estimated prior to 1947
[d] Actual production reported by Bureau of Mines
[e] Allocations and ratios to original discoveries computed by author, based upon field studies and extrapolations over a period of 7 to 8 years following original discoveries
[f] Reserves Committee reported 38,242 mill. bbl., Jan. 1, 1960
[p] Preliminary data, subject to final revision
* Estimated on basis of recent experience

EXPLORATION EXPENDITURES — 1959 [p]

Drilling Cost	Number of wells drilled	Average cost per well	Total cost (Thous. $)
Wildcat oil wells	965	118,586	114,436
Wildcat dry holes	8,842	84,390	745,076
Total wildcats [a]	9,807	87,462	859,512
Development dry holes	10,467	53,870	563,857
Total drilling cost	20,274	70,206	1,423,369
Other Charges			
Leases, land department		26,400	535,234
Geological and geophysical	20,274	13,100	265,589
Overhead		5,770	116,981
Total other charges	20,274	45,270	917,804
Total exploration cost	20,274	115,476	2,341,173

COST OF WILDCAT PRODUCERS AND ALL DRY HOLES

	Wildcat oil producers (Thous. $)	All dry holes (Thous. $)	Total cost (Thous. $)
Drilling cost	114,436	1,308,933	1,423,369
Other charges	43,686	874,118	917,804
Total cost	158,122	2,183,051	2,341,173
Number of wells	965	19,309	20,274
Drilling cost per well	$118,586	$ 67,748	$ 70,206
Total cost per well	$163,857	$113,058	$115,476

TOTAL WELLS DRILLED AND FOOTAGE

	Wildcats	%	Development wells	%	Total wells	%
Oil	965	9.6	25,252	64.5	26,217	53.1
Gas	323	3.2	3,440	8.8	3,763	7.6
Dry	8,842	87.2	10,467[b]	26.7	19,309	39.3
Total	10,130	100.0	39,159	100.0	49,289	100.0
Average depth	4,880	—	3,947	—	4,140	—
Footage*	49,434	24.2	154,561	75.8	203,995	100.0

[a] Excludes gas wells
[b] Excludes service wells
* Thousand feet
[p] Preliminary estimates

these responsibilities, and are sincerely dedicated to the tasks involved in keeping the nation self-sufficient of oil and gas.

Yet, it is obvious that these planned objectives can be achieved only under a continued favorable economic and political climate. Inadequate oil prices and an ill-advised reduction in the industry's depletion allowance could seriously disrupt the attainment of these well-intentioned objectives.

Other industries dependent. Any deterrent to the continued progress of the petroleum industry affects not only the industry itself, but many other basic industries which depend upon oil and gas operations for the utilization of their goods and services.

Already, the slump in the oil and gas industry's drilling operations has contracted the markets for steel products, with the result that many gainfully-employed workers have been laid off. Many basic industries, from which the petroleum industry buys huge volumes of products, are directly affected by a slow-down in drilling for oil and gas.

Yet, it is evident that otherwise, under favorable future economic and political conditions, the outlook for the petroleum industry and those industries which prosper because of it appears to offer a protracted period of vigorous expansion to meet the growing requirements for oil and gas.

Petroleum supply depends on investment capital. From any sound viewpoint, it is profoundly evident that the future supply of petroleum in the United States is dependent primarily upon a sufficient flow of investment capital. Long-range commitments necessarily entail incremental expenditures which must be supplied through earnings, borrowed capital and the retention of funds provided by the statutory depletion provision. The records of the petroleum industry's achievements, through the soundly-proved policies under which it has been operating for many years, offer a well-founded reason to believe that a continuance of these policies will best guarantee the future sufficiency of petroleum in the United States. ★ ★ ★

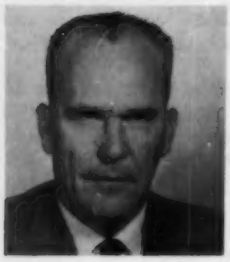
HOW EXPLORATION COSTS COMPARE WITH CRUDE VALUE

Year	Gross Crude Production (mill. bbl)	Average Price per bbl	Gross Values of prod. (mill. $)	Net Working Interest Value (mill. $)	Value Index 1947-49 100	Exploration Cost (Mill. $)	Cost Index 1947-49 100	Exploration Cost % of Value
1947	1,857	$1.93	3,578	3,059	80	904	82	29.5
1948	2,020	2.60	5,245	4,484	106	1,135	103	25.3
1949	1,842	2.54	4,675	3,997	104	1,255	114	31.4
1950	1,974	2.51	4,963	4,243	110	1,439	131	33.9
1951	2,248	2.53	5,690	4,865	126	1,740	157	35.7
1952	2,290	2.53	5,785	4,946	129	1,987	181	40.2
1953	2,357	2.68	6,327	5,410	141	2,329	212	42.1
1954	2,315	2.78	6,425	5,493	143	2,251	204	41.1
1955	2,484	2.77	6,870	5,894	153	2,428	221	41.3
1956	2,617	2.79	7,297	6,239	162	2,622	238	42.0
1957	2,617	3.09	8,079	6,908	180	2,387	228	34.6
1958	2,449	3.01	7,380	6,310	164	2,212	204	35.1
1959	2,574	2.92	7,516	6,426	166	2,341	213	36.4
Totals	29,644	$2.70	79,830	68,274	—	25,057	—	36.7

RESERVES FOUND PER WELL AND PER DOLLAR OF EXPLORATION COST

Year	New Res. Disc.[a] (Mill bbl)	Disc. Oil Wells Compl.	Res. Disc. Per Disc. Well (thous. bbl)	Exploration Wells Drilled	Res. Disc Per Exploration Well (thous. bbl)	Total Exploration Expend. (thous. $)	Res. Disc. Per Exploration Dollar (bbl)	Dry Holes Drilled[c] Per Mill. Bbl Disc.
1936-38	5,544	725	7,647	18,483	300	623,700	8.90	3.20
1939-41	4,450	1,049	4,242	20,907	212	817,548	5.44	4.46
1942-44	2,883	1,333	2,163	20,151	143	1,208,919	2.39	6.58
1945-47	5,106	1,966	2,597	27,990	182	2,461,722	2.06	5.10
1948-50	7,449	3,298	2,259	43,122	172	3,830,190	1.94	5.35
1951-53	7,821	4,943	1,582	59,682	131	5,955,405	1.31	7.00
1954-56	7,662	5,144	1,489	67,332	113	7,300,778	1.05	8.08
1957-59	6,885	3,142	2,191	61,383	110	6,939,837	.99	8.45

[a] Initial discoveries, new fields and extensions, excluding revisions in previous estimates (gas liquids extensions estimated)
[b] Excludes gas producers
[c] Dry holes drilled in exploration and development



BRYAN L. DENSON, *Petroleum Consultant, Amarillo, Texas*

GIANT TEXAS PANHANDLE

Second in the U. S. only to East Texas, cumulative production may reach the one billion-barrel mark this year. Waterflood potential can still keep this giant going strong

SURPASSED in the United States only by the East Texas Oilfield in total crude oil produced, the 39-year old Panhandle Oilfield seems to be stirring itself, going through a change in life, trying to decide whether now is the time to give up the ghost or to show that it has the strength to remain the giant among oilfields which it has been for over 30 years.

Its boom time was in the years just before the Wall Street Crash of 1929. Along with the Great Depression it suffered, due

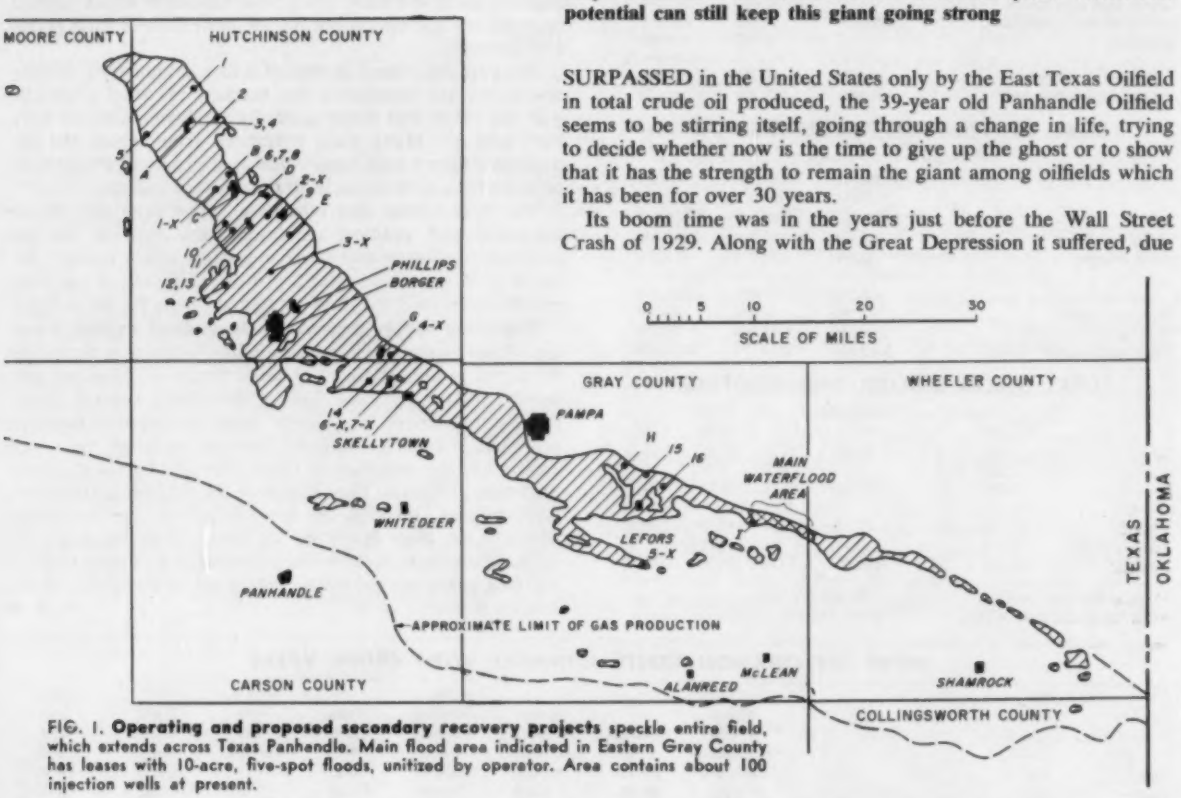


FIG. 1. **Operating and proposed secondary recovery projects** speckle entire field, which extends across Texas Panhandle. Main flood area indicated in Eastern Gray County has leases with 10-acre, five-spot floods, unitized by operator. Area contains about 100 injection wells at present.

Active Projects

Code	Number of injection wells	Number of producing wells	Average daily production per well	Cumulative production per well thousands
1	1	41	5.0	40
2	1	15	2.0	77
3	4	18	4.5	71
4	1	21	3.7	61
5	4	24	3.5	26
6	1	7	3.5	56
7	1	7	2.5	63
8	1	9	3.0	45
9	10	56	5.1	32
10	4	33	2.5	24
11	4	35	2.3	26
12	1	14	1.0	28
13	1	21	2.0	40
14*	1	7	2.0	23
15**	3	26	14.5	137
16**	1	8	3.0	36

Approved or Applied for Projects

Code	Number of injection wells	Number of producing wells	Average daily production per well	Cumulative production per well thousands
A	—	7	4.0	54
B	2	4	3.0	11
C	—	17	2.5	51
D	6	38	3.5	16
E	1	73	1.9	109
F*	—	20	3.0	18
G	—	108	5.0	75
H	—	169	9.0	50
I**	—	5	2.0	10

Abandoned Projects

1-X	1 Old Well	Abondoned in 1956
2-X	9 New Wells	Abandoned in 1955
3-X	1 Old Well	Abandoned in 1950
4-X	6 Old Wells	Abandoned in 1958
5-X	1 Old Well	Abandoned in 1956
6-X, 7-X*	5 Old Wells	Temporarily abandoned in 1960

*Producing Zone includes Arkosic Dolomite.
**Producing Zone includes Granite Wash.
Others are Brown and/or White Dolomite.
The Main Flood Area in Eastern Gray County has leases with 10-acre 5-spot floods, unitized by the operator. Also, there are cooperative agreements between offset operators. A unitization application has been approved by the RRC for several offset operators. This area involves approximately 100 injection wells at present.

OILFIELD AT THE CROSSROADS

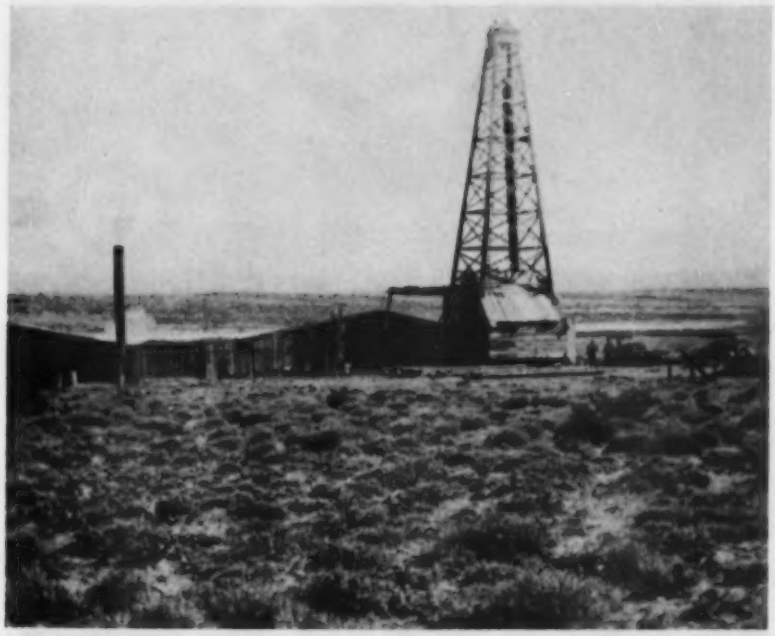


FIG. 2. **Cable tool rigs** drilled first wells in Panhandle Oilfield during mid-1920's.

to the glut of oil furnished by the Oklahoma City and East Texas Fields during the early 1930's. Development of the field almost stopped during those days. At one time there was only one rotary rig running.

The situation became almost as bad during World War II when manpower and materials were drafted or diverted. During the last few years there have been thousands of new wells drilled for marginal production.

Now, at a time when the entire oil industry is precariously balanced on the knife edge of over-supply and threatened price cuts, this huge field is threatened with thousands of abandonments if the price of oil falls, versus the promise of hundreds of millions of barrels, a billion or more, of additional oil if present hopes can be realized. These are not for the small margins of new extensions, cheaper drilling, or better completions, but for better methods of secondary recovery.

How Field Developed

The Panhandle Oilfield was discovered in 1921. Early major development began in 1925 and lasted until 1930. Development of field extensions has been more or less continuous since then, the rate depending upon the economic conditions at the time. New developments in drilling and completion techniques have resulted in the development of areas with less and less pay section and oil reserves.

New wells, workovers with new techniques, and pressure maintenance by gas injection have kept the annual rate of production fairly constant at about 30,000,000 bbl per year since the economic recovery of the late 1930's. This new work helps balance the loss of production from older leases, many of which show declines of 30% per year. There are now more than 12,000 producing oil wells, 2½ times the number of wells 20 years ago, averaging less than 7 bbl per day. The cumulative production for the field will reach one billion barrels in 1961.

Where field extends. The field is over 100 miles long, extending from Collingsworth County at the southeast corner of the Texas Panhandle to Moore County in the northwest part. It crosses Wheeler, Gray, Carson, and Hutchinson counties, varying in width from a few locations to over 10 miles. It is continuous except at the southeastern end where there are some small skips and along the southwestern flank where there are scattered outpost pools. All underlie the Panhandle Gasfield.

Within the field there are barren spots due to porosity changes and to granite peaks which occasionally pierce the oil zones. The field lies mostly on the northeast flank of the buried Amarillo Mountains, a granite ridge extension of the Wichita Mountains of Oklahoma.

Oil is found in the series of dolomites, limestones and granite washes at depths approximately 100 ft below sea level to 200 ft above. The well depths vary from 2100 ft in Collingsworth County to over 3400 ft in Moore County.

The original gas, oil, and water contacts were essentially uniform within local areas of the field, indicating that there was a measure of vertical permea-

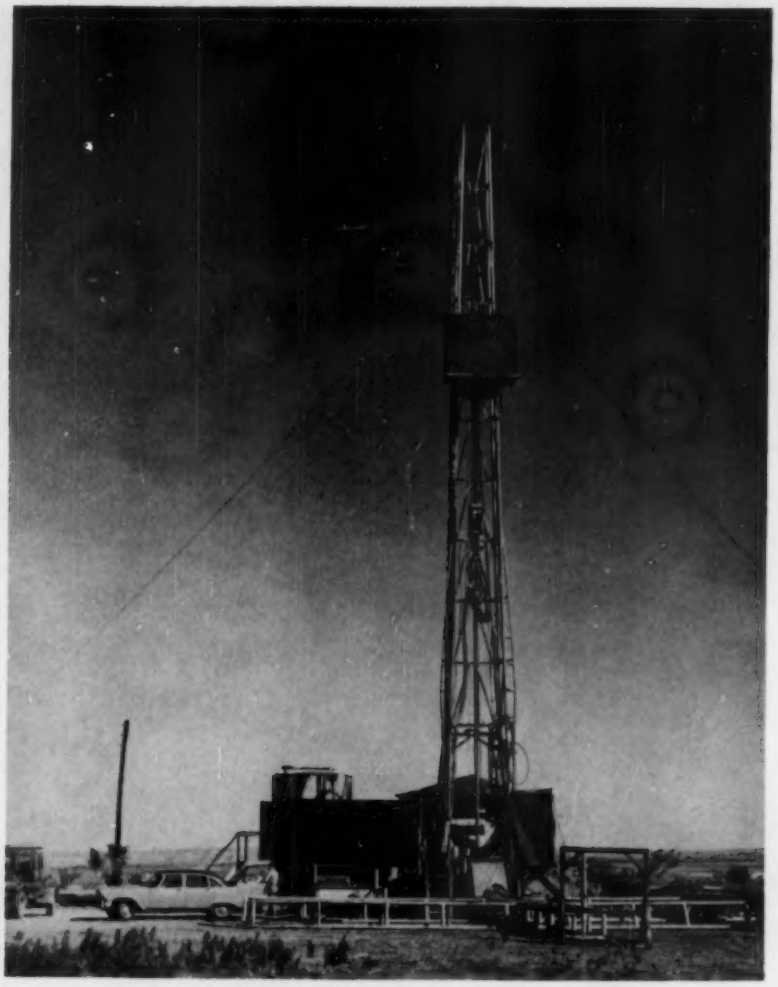


FIG. 3. **In last few years,** thousands of new wells have been drilled with modern rigs for marginal production. Drilling injection wells for secondary recovery waterflood has been part of the drilling program.

bility between the various pay zones.

The original pressure of the reservoir was 430 psi. This has declined to almost atmospheric in some of the older areas. Occasionally, gas wells are completed in these areas and find initial pressures even lower than 40 psi.

In new areas, gas wells still find pressures up to 400 psi. Oil wells also find these higher pressures in more isolated areas. The pay zones are somewhat lenticular with widely variable porosity and permeability values.

The average for the field might be 30 ft of net pay with 15% porosity, 40% water saturation, and 25 md permeability. The best areas have three times this much pay while some of the newer areas have only one third as much.

The crude oil averages 40 deg API but has a high paraffin content. At a reservoir temperature of 90 deg the viscosity is approximately 10 cp.

Solution gas expansion has been the principle producing force with gravity, pressure maintenance using gas, gas cap expansion, edge and bottom water encroachment, and water or miscible phase flooding playing minor parts. Estimates of the residual oil vary widely, but between one and two billion bbl remain to be recovered by secondary means.

Most of the early wells were drilled with cable tool rigs all the way. If stimulation was needed, nitroglycerin in either liquid or jellied form was used. Later, the practice of using rotary tools to set the production string of casing became popular. Due to the low formation pressures, cable tool rigs were still used to drill the pay section and clean out after shooting.

Most of the wells are now being drilled with rotary all the way, cementing casing through the pay, making the completion through perforations, and using sand fracturing methods.

Recovery From Gas Injection

Gas injection for pressure maintenance has been used since the early 1930's. At present there are several active projects, the most successful and extensive being the West Pampa Repressuring Association and the Watkins Gas Injection Projects, each having over 1000 wells in their respective areas.

There have been a number of other gas injection projects abandoned over the years for various reasons.

There have also been a few isolated and partially successful attempts to recover additional oil by LPG injection followed by gas and water. The availability and cost of the LPG makes it more attractive at times, but the low pressure of the reservoir in most areas limits the effectiveness of this method.

Recovery From Waterfloods

There are 17 companies at present either actively engaged in carrying on waterflood programs, pilot tests, or in making plans to begin such tests. These companies have approvals from the Texas Railroad Commission for over 25 projects and 50 leases.

In addition to these, there are several proposed cooperative projects of large magnitude which are in the process of being organized. There have been several leases unitized under one operator and there are unitization projects underway between companies.

Prior to the present activity, there have been several other attempts to waterflood which have failed and have been abandoned. Why these early projects failed and why some others now being tried have shown no or only partial success needs to be carefully examined. Otherwise, hundreds of wells are in danger of being flooded out and abandoned with very little if any benefit.

The recent increase in waterflood interest has been brought about by the success of intensive waterflood programs in one area. Also, more pressure is being brought to bear on oil producers to dispose of salt water without contaminating the fresh water supplies. Admittedly, some projects are simply means of disposing of salt water. Some combine fresh water with the salt water to obtain more volume.

Most are projects in the experimental stages to gain experience for the expected general waterflood to come.

In 1955, in eastern Gray County, a pilot flood was started, using one old well and one new well for injection purposes. As a result of this pilot, other new wells have been drilled in this area for water injection.

A net increase of over 2200 bbl per day of waterflood oil can now be credited to these floods. With the present production rates, these projects will pay out within another year, or within two years of the major investment.

The production from these wells represents 3% of the entire field from 1% of the producing wells. The increases on these leases are more in the range of 5 to 10 times their normal expected production.

Some pilot floods yield little. As a result of this flood other companies have started a rash of pilot floods, most of them using old producing wells for the injection of the water.

These new projects consist of one well injection tests, two to three wells, single five-spots with four injection wells, or adjoining five-spots with six injection wells. Some of these tests have shown slight temporary increases in production while others have shown no response. The best of these have recovered between 5000 and 10,000 bbl of oil per producing well before watering out.

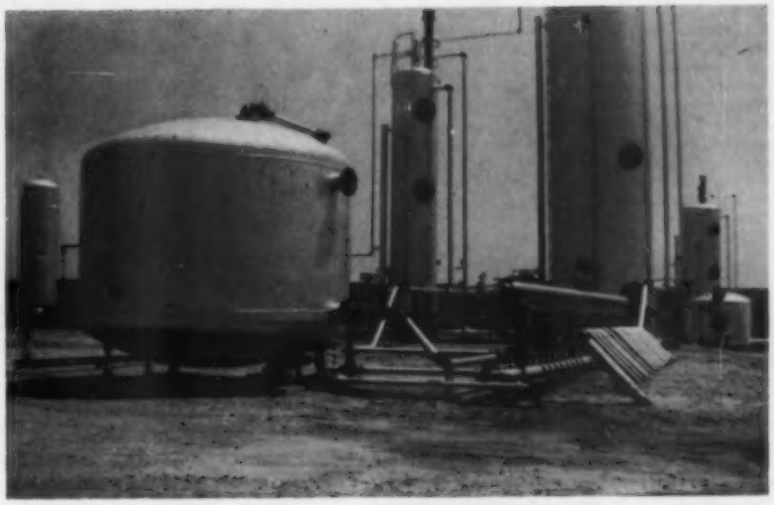


FIG. 4. **Filtration and treating equipment** are typical of modern installations on many of the newer leases.

As much as 4,000,000 bbl of water have been injected in several areas with only 1% or less of this volume being returned as oil in offset wells. Also, increased water production can account for only a small part of this. Appar-

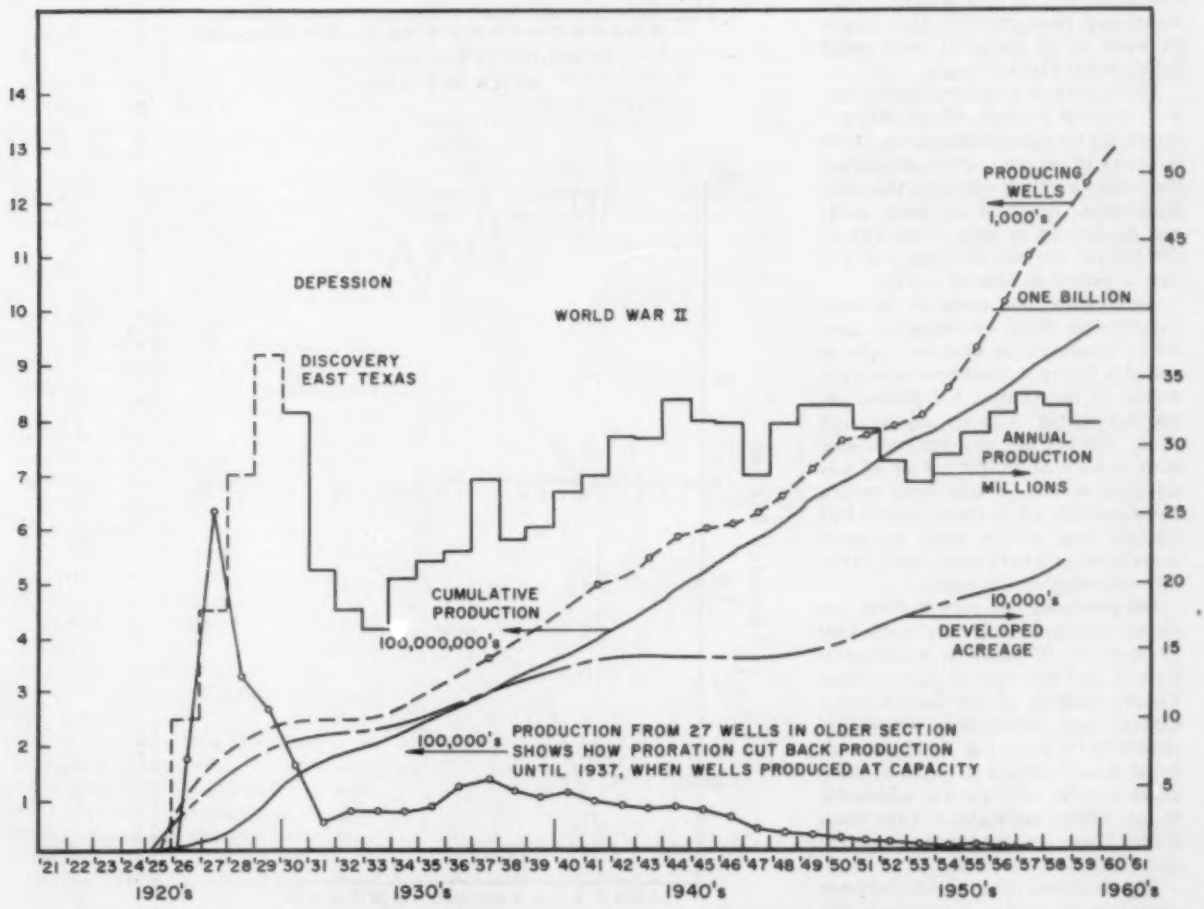
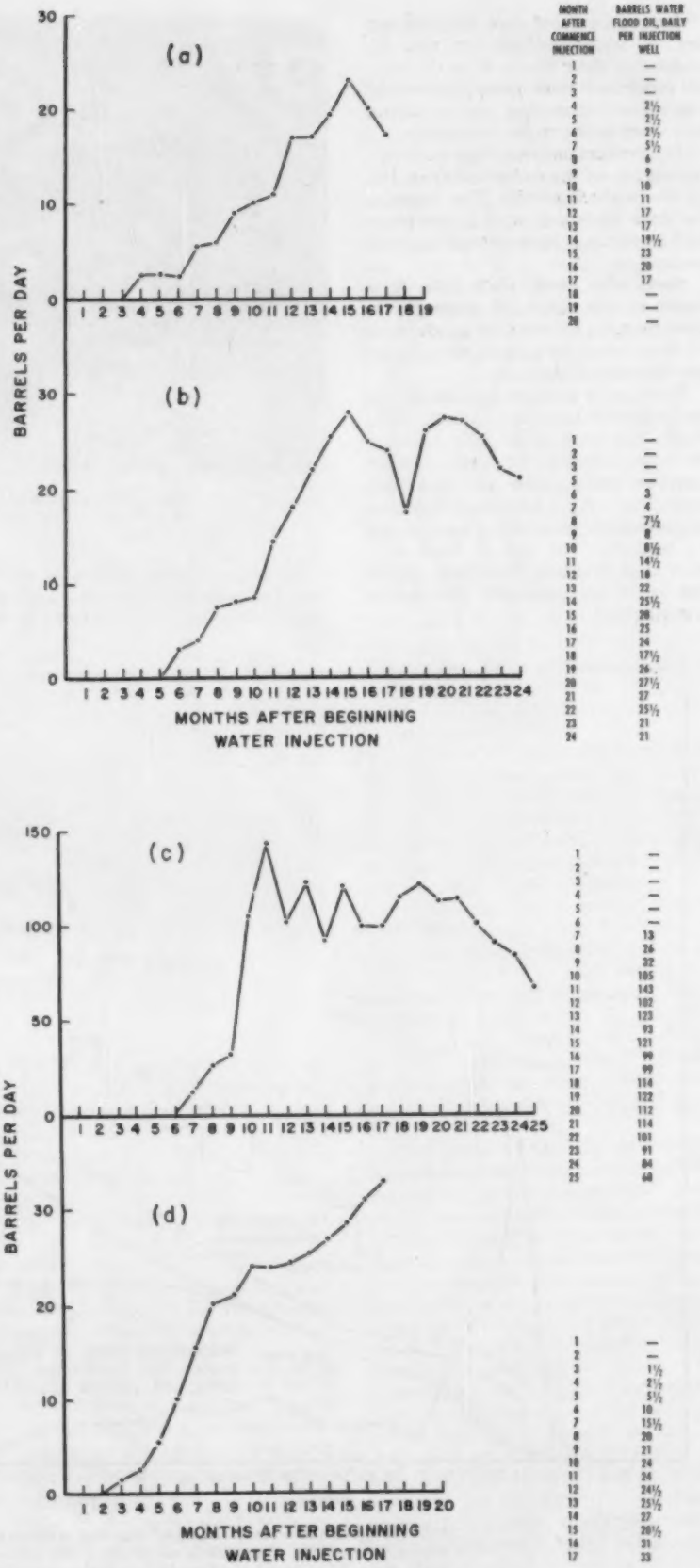


FIG. 5. **Production history** since field discovery shows sizable annual yield, averaging about 32 million bbls in recent years. Extensive waterflood effort could possibly recover another billion bbl before field is depleted.

FIG. 6. **Performance of some current flood projects** in the giant Panhandle field of Texas. **6-A** and **6-B** showed response after injecting water equalled to about three or four times the cumulative oil production up to that time. **6-C** Water injected at much higher rate to recover oil five times faster than floods shown for **6-A** and **6-B**. In **6-D**, new injection wells were drilled and with closer spacing, the area responded rapidly without excess water.



ently, in most cases, practically all the injected water has been lost to other formations.

In one early attempt to carry out a pilot flood, nine new wells were drilled for water injection. Completions were made to flood both the Brown Dolomite and the White Dolomite by gravity injection into each. After breakthrough of water, surveys showed that it was leaving the injection wells through the White Dolomite.

After plugging of this section, water production was materially reduced. Later, when breakthrough occurred again, it was found that the water was leaving the injection wells through the Brown Dolomite. This project was abandoned after over 4,000,000 bbl of water had been injected. Only slight increases in oil had ever been noted before water breakthrough.

There were at least three early one-well injection projects which obtained essentially the same results. Only minor increases of oil were produced before the wells watered out and the tests abandoned. Injection in these wells was by gravity at rates from 100 to 200 bbl per day per injection well and over a period of several years.

An attempt was made by another company to flood by using six converted producers as injection wells in a double five-spot. Two new wells were drilled in the centers for production and for testing. Gravity injection of about 300 bbl per day per well were used. A total of 35,000 bbl of oil was reported as due to this flood before abandonment. All of these projects had injected four to ten times as much water as should have been required before obtaining any response.

Oil produced. At present there are eleven companies injecting water into 39 wells on 20 leases in Hutchinson, Carson, and the western part of Gray County, outside of the eastern Gray County area mentioned. These are shown on the map, Fig. 1. Three companies have approval to begin injecting water in nine wells on five additional leases. Other applications have been made. These are in addition to purely water injection projects.

Fig. 6 shows comparisons between some current projects in relation to the added oil recovery per day per injection well. The amount of water re-

quired in the first three examples before obtaining response was approximately the same, between three and four times the cumulative oil recovery per well for the area.

This was true although 6-C had a cumulative oil recovery twice that of the others. The fill-up time happened to be approximately the same because 6-C injected water at twice the rate of 6-A and 6-B. The rate of oil recovery per injection well of 6-C is approximately five times that of 6-A and 6-B as a result of either the higher rate of injection or better formation conditions and control of the water.

While 6-C has a more erratic rate due to water breakthrough and flooding out of wells, both 6-A and 6-B have had the same difficulty but do not reflect it as much in the graph due to the larger number of wells involved. There is some justification for a belief that this erratic water breakthrough into certain wells indicates that an oriented fracture pattern exists which might make it more beneficial to use a line flood instead of a five-spot pattern.

Fig. 6-D is in the eastern Gray County area and involves a large number of injection wells. This area has had a higher cumulative oil recovery by primary means. Being on much closer spacing and using new wells for injection, this area had a rapid response without the excess water needed by the others.

However, when comparing 6-D against 6-C, the difference in recovery rates per injection well brings up the question of the vast difference in new investment due to drilling the new injection wells. It may take years to decide which practice was best.

High injection rate necessary for good response. All of these projects are alike in that even after responses are shown in the offset producing wells there were huge losses of injection water into other zones. Some of the earlier projects, at slow rates of injection, had shown little, if any response. This indicates that a high rate of injection, 300 to 1000 bbl per day per well, especially in most areas, is necessary to obtain a good response.

Against the theory of a high rate of injection is the early watering-out of wells. But watering out has also occurred at low rates and without any oil recovery.

It is very probable that often only the highly permeable, more fractured zones are being flooded and that high rates are needed to create an oil bank in this type of permeability. An excess of water is being drained off at all times by vertical fractures into other zones.

In line with this thinking is the knowledge that the formation in general will not stand very much pressure. Greatly increased rates of injection will occur in some areas when the pressure exceeds that of the original, equal to only 1000 ft of water column against the formation.

FIG. 7. **Automatic custody transfer** is among other modern production developments to be found in the field to improve efficiencies.

Recovery limited but practical. While present indications in most of the field are that only a small part of the oil might be recovered by these floods, they are still practical.

When the average production of the wells reaches two to three bbl per day, there is a strong temptation to plug them, reap what salvage there may be, and get out.

The prospect of recovering any quantity of increased oil through water injection for a short while before plugging, without further major investment, is very tempting also. For example, 6-C, with a daily average of only 3.5 bbl per well, making only a very small net income, has shown over 50,000 bbl of added oil in two years as a result of converting one producing well into an injection well. More than a total of 100,000 bbl of waterflood oil will be recovered before abandonment. This oil, while only adding 25% to the primary, is being produced at a very nominal additional cost. This is for the water which is being supplied at less than 10% of the net revenue from the additional oil.

While 40,000,000 bbl of water have already been injected into the Panhandle Oilfield, this is only 4% of the cumulative produced oil. After water injection becomes more general and

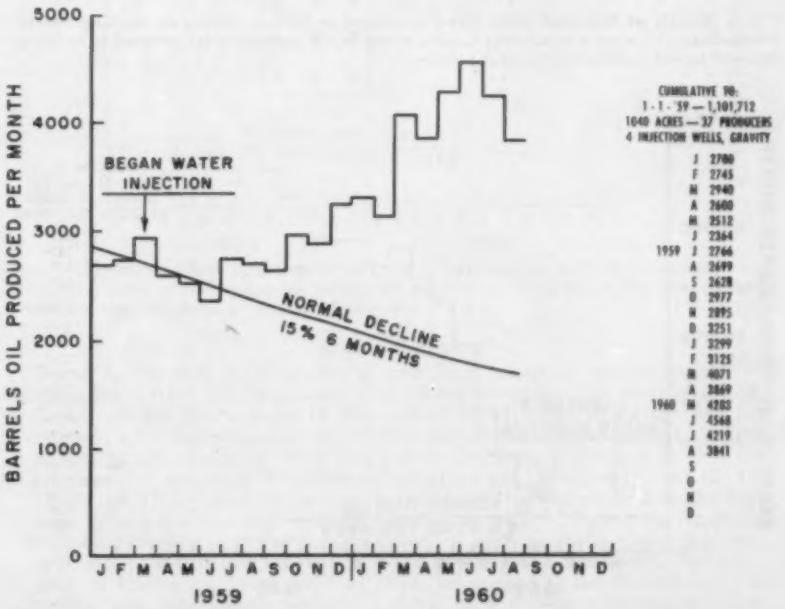


FIG. 8. **Four-well pilot flood** was developed on 20-acre spacing with an old producer converted to water injection well to make one 40-acre, five spot pattern on the Creslenn-Whittenburg (A) lease in Hutchinson County, Texas.

more pressure has been returned to the reservoir, higher recovery rates and better recovery efficiencies will be obtained.

In the meantime, some leases may be flooded out with only partial recovery. Some smaller leases may even lose what small production they now have and not benefit at all. Regardless of the consequences, flooding of the field has started and it is passing from the testing stages into general flooding of whole areas.

Some of these projects are premature in the respect that many mistakes are repeated too often. The different zones to be flooded, the rate of flooding, the type of flooding for each zone, the flood pattern, the source of flood water and its treatment, and the equipment required for injection and production should all be very carefully considered before starting a flood.

The Brown Dolomite is the best prospect for conventional waterflooding. The White Dolomite, Arkosic Dolomite, and the Granite Wash have all shown some slight positive responses but will require different treatment. It is possible that imbibition will play a larger role in the response of the White and the Arkosic due to the greater prevalence of fracturing. The permeability of the Granite Wash is so erratic that it may be impossible to predict what will happen.

At present, the rate of flooding appears to be a highly critical factor in the Brown Dolomite. The highest rates used so far, in the range of 1000 bbl per day, have given the best results. Low rates, below 300 bbl per day, have given very little, if any, response. The White Dolomite, Arkosic Dolomite, and the Granite Wash have given slight response at high rates, and little or no response at low rates. Some treatment other than conventional waterflooding may be required for these.

Flood patterns have been established in the eastern Gray County area by five-spots. In Hutchinson County, there is a strong temptation to use a line flood due to the responses obtained to date and the belief in a certain east-west fracture pattern.

As only pilot floods have been used in these areas, the effectiveness of fully-developed flood patterns have not been demonstrated. In addition to the multiple effect of balanced flooding, the control of water in the injection wells has been lacking in nearly all projects.

As soon as more extensive flooding becomes developed and the injected water is better controlled into the proper zones, there should be some very respectable results.

Most of the present flood water is being supplied by the shallow, freshwater, Ogalalla stand. Other water has been supplied by surface streams. Due to the irrigation demands for these same waters, a search has been made for other sources.

The Glorietta sand at about 1000 ft has been found productive in some areas and may develop into the major source for the future. It is brackish and indicates a high volume and pressure, requiring only moderate power requirements for supplying large volumes.

There are also other deeper zones which have been seriously considered as flood water sources. Very little work has been required to date in the matter of water treatment. Sulphate deposition in the injection wells may be a problem to contend with when using shallow or surface waters.

Whether to install water injection pumps or to depend upon gravity injection is a question. Recent work in Hutchinson County indicates that injection pumps may be required, even though gravity injection has been used

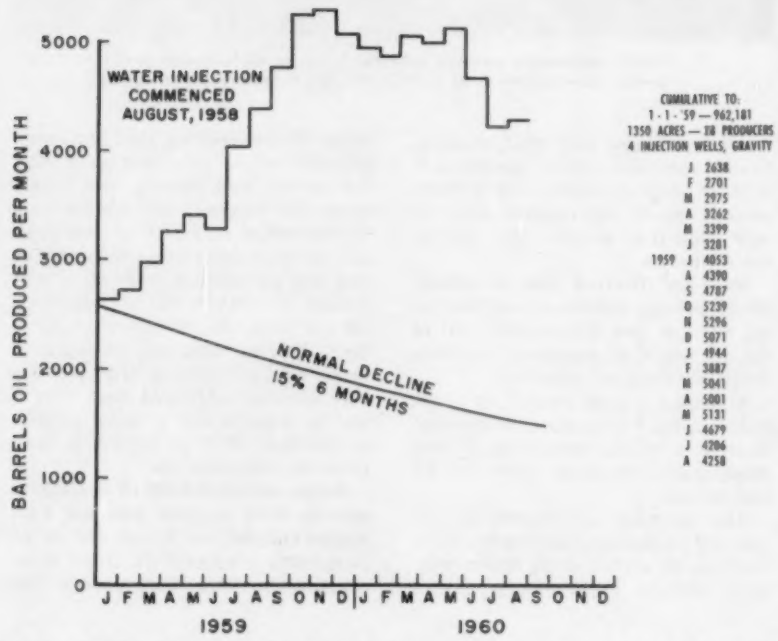


FIG. 9. **Results of four-well pilot flood** developed on 20-acre spacing on the Continental-Whittenburg (A) lease in Hutchinson County, where an old producer was converted to an injection well to make a 40-acre, five-spot pattern.

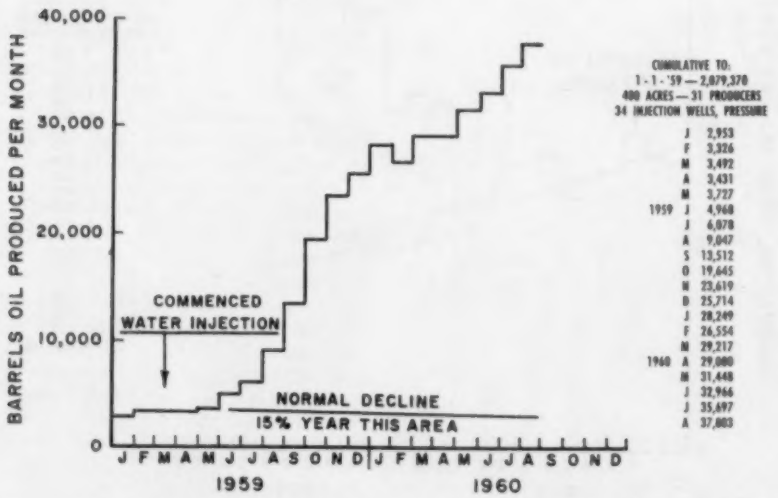


FIG. 10. **Completely developed flood** on the Kewanee-Webb lease in eastern Gray County, totalling 400 acres, 31 producing wells and 34 injection wells. Flood developed on a 10-acre, 5-spot pattern.

in wells at rates up to 1000 bbl per day.

When the capacities of the Panhandle oil wells to produce are considered in relation to their depths and low pressures, it may prove to be that even much higher rates of injection, in the range of 2000 or more bbl per day may be required to obtain the optimum flooding rates. If so, then injection pumps will be required.

Also, when cycling of water becomes necessary, much larger pumping units on the producing wells will be required.

More Experiments Needed

While conventional waterflooding has been proven successful in the Brown Dolomite, and generally a failure in the other zones, not enough experimentation has been done to obtain better results.

Anything which can be done to lessen the oil viscosity, reduce its surface tension, increase the water-wettability of the reservoir rock, and at the same time increase the injectivity of the injection wells into the oil zones and producibility of the producing wells without causing interference into or from other zones will help. Among the possibilities are the CO_2, LPG, raw gasoline, or gas injection methods along with or slugged ahead of water.

Also, the injection water may be treated in other ways by chemicals or by heating to obtain some of the desired results.

In situ combustion for a short period, followed by water, may provide the heat and other products which would assist in freeing the oil.

Definite plans are being made at this time on some of these methods and the prospects are good.

Realizing Future Production

Much more will be learned from these present projects which will help the oil producers decide their problems; whether to salvage marginal wells now, dump flood at high rates for a quick return before salvaging, or, to invest in new injection wells, new surface equipment, and much more needed research in order to recover the maximum amount of oil.

When the vast potential of secondary recovery oil from the Panhandle Oilfield is realized, with some present floods having recovered 750 bbl per acre in one year and indicating an ultimate of over 5000 bbl of waterflood oil per acre, then the one billion bbl or more of secondary oil for the entire field comes into the range of possibility.

The Panhandle Oilfield may once again experience a surge of new life, keeping it among the very top oil producing fields of the nation. * * *

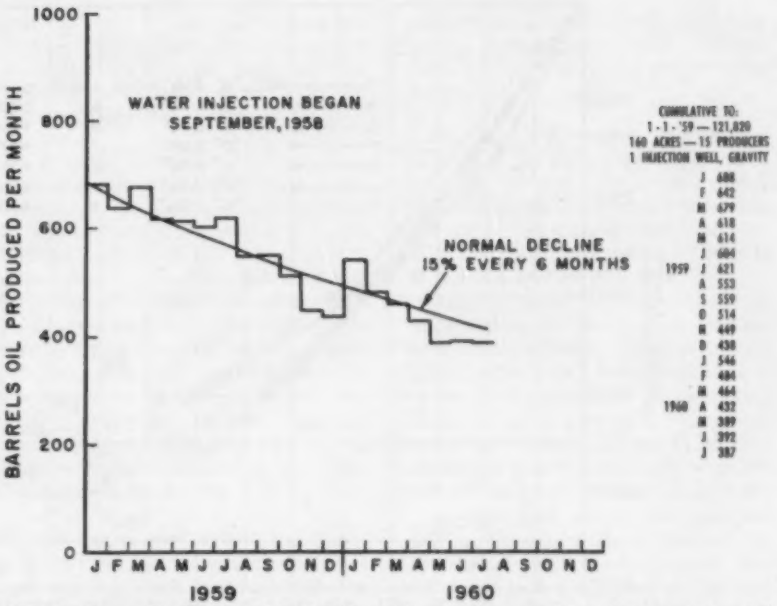


FIG. 11. **One-well pilot flood** in Hutchinson County where an old producer was converted into an injection well, making up a 20-acre inverted five-spot pattern.

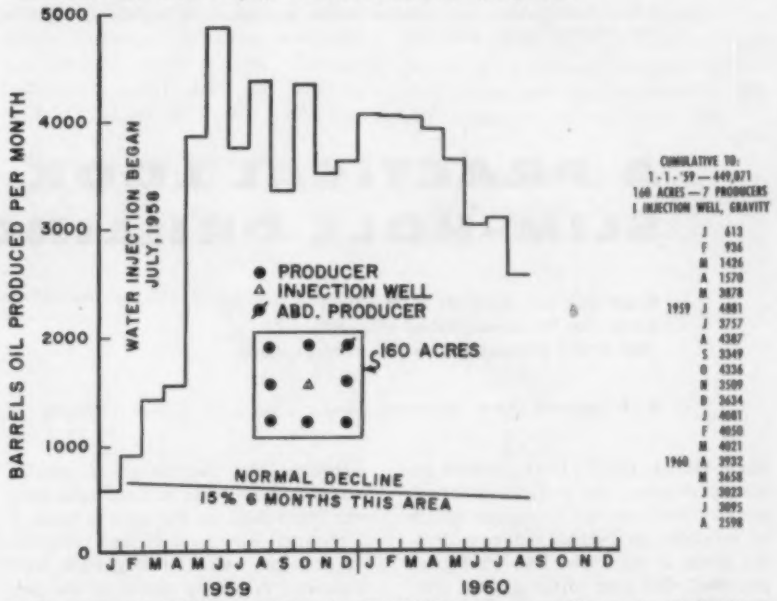


FIG. 12. **Example of high injection rates** (1000 bbl per day per well) on a 1-well pilot flood developed on about 16-acre spacing with an old producer in the center of the lease converted to an injection well, making an inverted nine-spot pattern.

ABOUT THE AUTHOR

Bryan L. Denson is a consulting petroleum engineer headquartered at Amarillo, Texas. Son of a cable tool drilling contractor, he worked in the Texas oilfields before going to The University of Texas where in 1941 he received a BS degree in petroleum engineering. From 1941 to 1945 he worked in the Permian Basin of West Texas as a petroleum engineer and division engineer for Magnolia Petroleum Company (now Mobil Oil) and G. P. Livermore. He installed the first pilot waterflood in the Kermit field during this time. After a two year tour in the Middle East as resident engineer forAramco, he joined Drilling and Exploration Company at Bakersfield, California and returned to West Texas in 1948 as a division engineer for Union Oil Company of California. From 1953 to 1959, he worked in the Middle East as drilling and zone superintendent, in Egypt as a drilling superintendent, in Nigeria (Africa) as directing engineer and manager of operations, and in the same capacity later in Brazil. He returned to the U. S. earlier this year to open his consulting engineering practice in Amarillo, Texas.

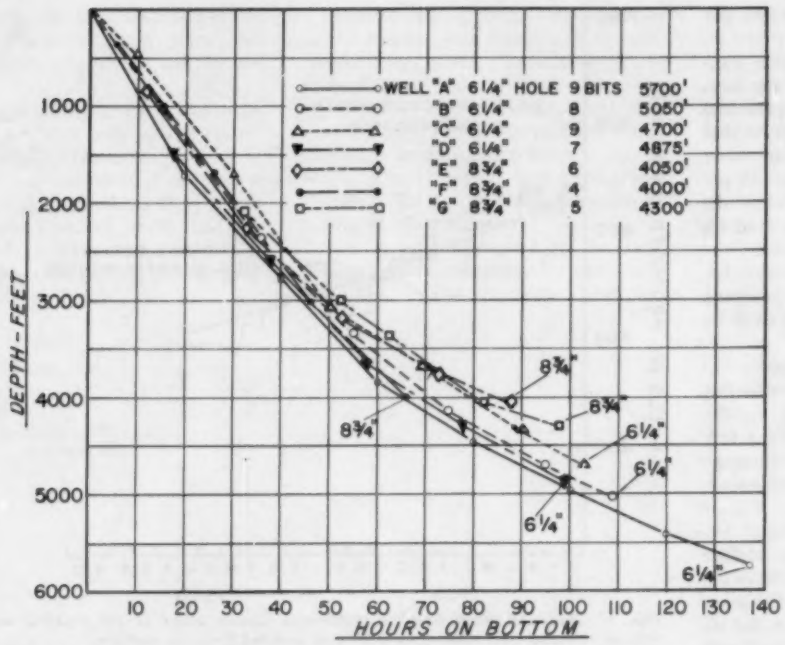


FIG. 1. Drilling rate curves compare drilling performance in 6¼-in. and 8¾-in. holes drilled in San Joaquin County, California.

A PRACTICAL LOOK AT SLIM-HOLE DRILLING

Economic development of marginal producing zones can be accomplished efficiently with slim-hole equipment . . . within certain limits

B. A. AGGERS, *Santa Fe Drilling Company, Santa Fe Springs, California*

SLIM-HOLE DRILLING involves no new principles: no radical practices are required, and the technique offers no infallible method of reducing drilling costs in all areas. But where applicable, slim-hole drilling can spell the difference between success and failure in many development operations.

As used in this discussion, a "slim" hole is one which is drilled to accommodate a completion casing string of less than 5½-in. OD, using properly-designed, highly mobile equipment and proven drilling practices to reduce drilling and completion costs. The use of conventional drilling equipment for drilling small diameter holes is not true slim-hole drilling.

Why Slim-Hole Drilling?

The development of the slim-hole technique and the design of special, scaled-down mobile drilling equipment was intensified by the serious need of a cheaper way to drill and complete oil and gas wells. **Drilling costs** have remained relatively stable in the past ten years, principally due to a marked increase in overall drilling efficiency. **Total well costs,** on the other hand, reflect the increases apparent in all phases of our economy, and have reached a level which may prevent maximum efficient oil or gas recovery from many marginal producing zones.

Drilling activity in the United States has steadily declined because of several factors: a poor balance between world crude demand and supply, the consequent unsteady crude price structure, and the soaring cost of land acquisition, rentals and conventional drilling and completion practices. There is a constant attempt to balance exploration costs with the odds against obtaining production in paying quantities in wildcat or step-out areas of interest. There are, of course, prospect areas which must be drilled on the assumption that protective casing strings may be required, with the resulting high costs of large diameter surface casing strings, protective strings, and large diameter drilled holes.

However, many wildcat, step-out, or marginal development areas can be successfully drilled and evaluated by using the slim-hole method, at an overall saving of from 15% to 30% over conventional drilling and completion costs. The prospect well may be logged, tested, cased, cemented, perforated, and placed on production in exactly the same manner as the larger, more expensive well.

Design of Slim-Hole Drilling

To enjoy fully the benefits of slim-hole drilling, you must use drilling

Based on a talk made by the author before the Los Angeles Basin Chapter of the API's Division of Production, September 21, 1960.

equipment specifically designed for minimum moving, rigging-up, and operating costs. There is no apparent cost advantage in using a conventional rig, requiring twelve to sixteen truckloads for drilling a 6¼-in. hole to 7000 ft, when a properly-designed slim-hole rig can satisfactorily accomplish the job with six to eight trailer-mounted rig components.

Since 1954 Sante Fe Drilling Company and its subsidiary, Exploration Drilling Company, have designed and built four complete slim-hole rigs for operation in the United States and foreign countries. Exploration Drilling is now operating two of these lightweight, highly mobile rigs in California fields with very satisfactory results. Santa Fe's rigs are operating in Cabinda, Africa, and in Colombia, South America on wells in the 1000 to 7500 ft depth range.

Basically, all of these rigs are identical, although some modifications have been made in the last three models. Major rig components are described below:

Drawworks semi-trailer. Double-drum hoist is powered by a 300 to 400-hp diesel engine with torque converter, through transmission. A 94-ft hydraulically-erected jacknife 210,000-lb capacity mast is mounted on this trailer and features two sets of traveling blocks — one set is used for hoisting the kelly, and the other is used for tripping the drill string. This unusual arrangement eliminates any need for "ratholing" the kelly, as the kelly blocks and kelly are retracted into the mast structure during trips.

Center rack semi-trailer. This trailer features an elevated steel sub-structure as a base for a 17½ in. rotary table, with an unobstructed clearance of 8-ft above grade, and a floor height of 9 ft 6 in. The forward trailer section is used as a center rack and has hydraulically operated extension legs to permit easy leveling and separation from the truck tractor.

The drawworks and center rack trailers are designed to engage and lock in position when mated, and form a rigid, integral unit for drilling.

Mud pump semi-trailer. The pump used on this trailer is designed and powered for the depth range desired; for 3000 to 6000-ft drilling, a 7¼-in. by 14-in. pump is generally used, and is driven by diesel engines through V-belt drives. Suction and discharge manifolds are mounted on the trailer's rear end, with spare parts storage and oil drum rack located on the trailer gooseneck.

Doghouse semi-trailer. An all-steel doghouse is mounted on a two-axle semi-trailer and features crew lockers and spare parts storage, with an air compressor, a 30-kw diesel-driven generator, switch panel, and 2000-gal diesel fuel tank mounted on the trailer gooseneck.

Pipe rack semi-trailers. The number of pipe rack trailers required varies with size of drill pipe or drill tubing and hole depth. Each trailer is capable of racking and hauling 3500 ft of 3½-in., 9.3-lb, N-80 drill tubing, or 2000 ft of 4½-in., 16.6-lb drill pipe.

Other major rig auxiliaries include a shale shaker, hydraulic tongs, 3½-in. by 40-ft square kelly with roller kelly bushing, Type "L" rotary swivel, a 5 in. by 6 in. centrifugal mud mixing pump driven by a 50 hp diesel engine, hydraulic blowout preventers to suit customers' requirements, and adequate drill collars for 6¼-in. to 9⅞-in. hole.

As described above, the complete drilling rig requires from five to seven semi-trailer loads, depending on drill string and well depth. Two truck tractors are used in moving the complete rig on short highway moves or local field moves, with outside trucking services being used only on longer highway moves. No cranes are required for normal moves, but may be needed if hillside locations are extremely tight.

Slim-Hole Drilling Savings

Site preparation. In many cases, our drilling contract prices for wells in the

TABLE 1. Conventional vs. Slim-Hole Casing and Cementing Costs

CONVENTIONAL COMPLETION		
Surface Hole Size	13¾"	
Surface Hole Depth	300'	
Surface Casing Size	9⅝" 32.30#	
Surface Casing Cost	300' @ $426.72/100'	$ 1,278.00
1-9⅝" Float Shoe	$115.00 ea.	115.00
3-9⅝" Centralizers	$ 30.00 ea.	90.00
		$ 1,483.00
Cement	131 sacks @ $1.65 ea.	216.00
Cement Truck		152.00
Top Rubber Plug		28.00
		$ 396.00
Completed Hole Size	8¾"	
Completed Hole Depth	4000'	
Casing Size	5½" 15.5#	
Casing Cost	4000' @ $213.85/100'	$ 8,550.00
1-5½" Float Shoe	$61.00 ea.	61.00
1-5½" Float Collar	$62.00 ea.	62.00
5-5½" Centralizers	$20.00 ea.	100.00
		$ 8,773.00
Cement	105 sacks @ $1.65 ea.	$ 173.00
Cement Truck		330.00
Top Rubber Plug		12.00
		$ 515.00
Total Casing and Cementing Cost		$11,167.00

SLIM-HOLE COMPLETION		
Surface Hole Size	9⅞"	
Surface Hole Depth	300'	
Surface Casing Size	7" 20#	
Surface Casing Cost	300' @ $272.19/100'	$ 815.00
1-7" Float Shoe	$76.00 ea.	76.00
3-7" Centralizers	$24.00 ea.	72.00
		$ 963.00
Cement	60 sacks @ $1.65 ea.	99.00
Cement Truck		152.00
Top Rubber Plug		12.00
		$ 263.00
Completed Hole Size	6¼"	
Completed Hole Depth	4000'	
Casing Size	4½" 11.60#	
Casing Cost	4000' @ $1.64/100'	$6,560.00
1-4½" Float Shoe	$50.00 ea.	50.00
1-4½" Float Collar	$50.00 ea.	50.00
5-4½" Centralizers	$25.00 ea.	125.00
		$6,785.00
Cement	50 sacks @ $1.65 ea.	$ 83.00
Cement Truck		330.00
Top Rubber Plug		12.00
		$ 425.00
Total Casing and Cementing Cost		$8,436.00
Net "Slim-Hole" Savings		$2,731.00
Per Cent "Slim-Hole" Savings		24.4%

San Joaquin and Sacramento Valleys have included site preparation as part of the "footage" rate. We have, in most instances, eliminated cellars and conductor pipe, and have used earth-moving equipment operated by local ranchers in excavating and grading, at a considerable saving.

Wherever possible, earthen mud suction pits have been used instead of the conventional manifolded steel mud tanks. Excavating and backfilling costs are relatively small when compared to investment required in lines, valves, and tanks and the cost of their maintenance and transportation.

Moving and rigging-up. One of the largest savings in the use of properly-designed slim-hole equipment is realized in the minimum moving and rigging-up charges. Two to four mile moves over flat country frequently require only four to six hours from release time on one well to spud-in time on the second well.

Highway moves of from 50 to 75 miles have been accomplished for as little as $800, including outside trucking charges. Moving conventional equipment of the same depth rating would require at least $1500 and possibly $2000 if mobile cranes had to travel a long distance.

Daily rig operating costs.

Labor. Our four slim-hole rigs have been designed for operation with three-man crews, as contrasted with the conventional rig's four men. A savings of approximately $85 per day is apparent in this reduced labor force, based upon eliminating three rotary helpers at $25 per day, and a payroll burden of 15%. This $85 per day reduction is the largest single daily operating saving, and can be achieved only by using equipment designed for efficient operation with three-man crews.

Depreciation. Daily rates for equipment depreciation vary considerably from one rig to another, depending on capital investment, age of equipment, type and size of drill string and drill collars, and individual accounting practices. Generally speaking, depreciation chargeable to slim-hole rigs is somewhat less than that attributable to conventional rigs of the same age and depth rating, because of a smaller initial investment in lighter weight equipment and drilling string.

Maintenance, overhead, and rig supplies. There is probably little difference in maintenance and overhead charges between slim-hole and conventional rigs of the same age and depth rating. Other daily rig costs, such as fuel, oil and grease, and equipment repairs will vary only slightly and are largely dependent upon the efficiency of the individual contractor.

Well costs. Included in this classification are daily operating costs not directly attributable to the rig, such as mud and chemicals, water, drilling bits, reamers, stabilizers, hole openers, core heads, and core barrels.

Less mud and chemicals are required for drilling a 6¼-in. hole than an 8¾- or 9⅞-in. hole, because of the proportionate reduction in mud system volume, although the saving in this item may be rather small on a total well cost basis.

Savings of 25% to 30% are possible in overall bit costs when a 6¼-in. hole is drilled in comparison with bit costs for 8¾ or 9⅞-in. hole. Even if 6¼-in. bits provide only 70% as much footage per bit, total bit costs should be approximately equal to 8¾ or 9⅞-in. bit costs.

Casing and cementing costs. Assuming a 4000-ft well is to be drilled with 300-ft of surface casing cemented to surface and a 500-ft cement column is required outside of the completion string, a tangible saving of 24% is apparent in using a slim-hole program in preference to a conventional design (See Table 1).

TABLE 2. Drilling Costs with Slim-Hole Equipment — 6¼-in. Hole

	Moving-in Rigging up Dismantling	Rig Supplies	Diesel Fuel	Total Depth ft	Drilling Time		Drilling Rate ft/day	Total Days	Total Contract Cost	Cost Per day	Cost Per foot
					Days	Hours					
A. Footage Basis—Total Cost Includes Bits:											
	$ 703.34	$410.22	$ 443.85	4,602	8	13	541	13	$ 11,643.86	$ 895.68	$2.53
	703.18	72.23	664.29	3,624	5	10	671	7	7,293.06	1,041.86	2.01
	550.68	418.31	444.77	4,676	9	10	497	11	10,175.33	925.03	2.18
	541.98	381.55	659.65	5,068	13	16	373	15	12,585.91	839.06	2.48
	517.43	50.00	669.11	4,434	8	18	510	10	8,827.34	882.76	1.99
	362.05	77.55	579.42	4,403	8	16	506	10	7,164.08	716.41	1.63
	367.69	91.62	424.03	4,000	6	9	625	8	5,460.81	910.13	1.37
	1,309.19	10.95	396.40	4,600	7	0	657	8	7,798.34	974.79	1.70
	765.67	155.91	631.20	3,300	5	12	600	7	6,190.35	884.33	1.88
Totals	$5,821.21			38,707				89	$ 77,139.08		
9-Well Average	$ 646.81	$18.75/day	$55.19/day	4,300	8	4	554	9.8	$ 8,571.00	$ 896.69	$1.98
B. Day Rate Basis—Total Cost Excludes Bits:											
	$ 225.33	$108.23	$ 450.86	2,388	6	4	385	7	$ 4,248.56	$ 606.93	$1.78
	356.39	493.37	1,609.58	4,095	28	10	144	30	18,148.93	604.96	4.43
	1,079.90	212.71	1,810.50	4,415	9	18	453	22	14,795.89	672.54	3.35
	230.26	68.70	379.19	1,014	3	0	338	4	2,750.88	687.72	2.71
	431.39	123.92	394.61	2,723	9	18	279	12	6,885.73	573.81	2.53
	337.39	—	335.85	3,500	5	6	660	7	4,161.83	832.36	1.19
	404.05	658.72	1,694.01	4,634	25	4	184	27	17,402.27	696.09	3.76
	903.14	406.52	1,241.74	4,012	21	0	191	26	13,372.04	514.31	3.33
	371.76	373.15	393.05	2,065	7	2	291	8	5,918.41	739.80	2.87
	632.48	23.86	845.47	5,196	10	12	495	11	8,020.69	729.15	1.54
	544.97	109.81	559.09	3,500	7	5	486	8	5,812.39	726.54	1.66
	1,308.13	85.62	297.31	3,000	5	18	522	7	4,779.10	955.82	1.59
	441.96	235.97	1,755.91	5,605	24	20	226	28	17,115.95	611.28	3.05
	618.80	177.14	529.70	3,000	11	13	261	14	8,291.10	690.93	2.76
	621.69	.34	238.78	2,700	5	15	482	9	3,786.01	420.66	1.40
Totals	$8,507.64			51,847				220	$135,489.78		
15-Well Average	$ 567.18	$14.00/day	$56.94/day	3457	12	0	360	14.7	$ 9,032.66	$ 614.47	$2.61

IN HYDRIL "FJ" AND TRIPLESEAL® CASING JOINTS...

COLLARLESS CONSTRUCTION

Saves Space

Runs Faster

Stays Tighter

YOU CAN SET larger strings of casing using Hydril "FJ" Casing Joints or Hydril Tripleseal Casing Joints. Absence of collars permits larger intermediate strings or liners.

Collarless pipe runs faster, too, without danger of damaging unstable walls... actually lends support to caving hole. May be run at full speed without hazard to casing accessories. And Hydril two-step thread speeds operations in making up two threads at once... self-stabbing, self-aligning.

ASSURES MAXIMUM SAFETY

Hydril's Two-Step Thread gives the additional benefit of *three* high-pressure seals. The center seal *alone* will hold pressure equal to the full API-rated internal yield pressure of the pipe.

"FJ" and Tripleseal are only two of many Hydril Casing Joints. Consult Composite Catalog or your Hydril representative for the full story.

DRILL PIPE...CASING...OR TUBING...
YOUR BEST CONNECTION IS HYDRIL!

SALES OFFICES
CALIFORNIA
Bakersfield
Los Angeles
Ventura
LOUISIANA
Harvey
New Iberia
OHIO
Youngstown
OKLAHOMA
Oklahoma City
Tulsa
PENNSYLVANIA
Rochester
TEXAS
Corpus Christi
Dallas
Houston
Midland
Odessa
WYOMING
Casper
NEW MEXICO
Farmington
NEW YORK
New York
CANADA
Calgary
Edmonton

HYDRIL COMPANY
714 WEST OLYMPIC BOULEVARD
LOS ANGELES 15, CALIFORNIA
FACTORIES AT
LOS ANGELES, HOUSTON, TEXAS,
ROCHESTER, PA.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Drilling Costs With Slim-Hole Equipment — 6¼-in. Hole

Table 2 lists actual costs incurred in drilling 24 wells in the San Joaquin and Sacramento Valleys during 1957-58. Nine of the 24 wells were drilled on a "footage" basis with bits furnished by the contractor, and were drilled to an average total depth of 4300 ft in 8 days and 4 hours, at an average total cost to the contractor of $1.98 per ft, which includes an average "move in-move out" cost of $646.81 per well.

Fifteen of the 24 wells were drilled in areas which had poor control on drilling time and bits. These wells were drilled on a "day rate" contract, with bits furnished by the operator.

It is interesting to note that the average "day rate" well reached a total depth of 3457 ft in 12 days, at an average cost of $2.61 per ft, including a "move in-move out" cost of $567.18 per well. Several of these wells were drilled through sections of basalt or other igneous rock, using 6¼-in. diamond core heads and 60-ft core barrels.

Penetration Rates — 6¼ vs 8¾-in. Hole

Fig. 1 presents a comparison of penetration rates between four 6¼ and three 8¾-in. holes in San Joaquin County, California, in 1959. All of these wells were drilled in the same geological province and penetrated identical sections.

In order to eliminate variations in trip time between drilling rigs used on these holes, depth is plotted against hours on bottom for each of the seven wells studied.

A close examination of the performance curves in Fig. 1 lead to the following conclusions in this area:

A. Penetration rates in 6¼-in. hole are equal to, or better than, those in 8¾-in. hole.

B. Best performance in the seven wells studied occurred in Well "A" in 6¼-in. hole.

C. Bit performance is approximately equal in all wells, although definite conclusions are complicated by the rather wide variations in total depths.

Slim-Hole Disadvantages

There are, of course, disadvantages apparent in the slim-hole method. Any attempt to drill small-diameter holes can give unsatisfactory results if not properly planned and executed. Some possible disadvantages are:

Drilling equipment availability. In order to fully realize the savings attributable to drilling small-diameter holes, the operator should use mobile, specially-designed equipment to be operated by as few men as possible. Rigs capable of economically drilling slim holes may not always be readily available to accommodate a particular spud date.

Multiple-zone completions. In areas capable of high volume, multiple-zone production, the setting of 4½-in. OD or smaller completion strings may be particularly unattractive. While successful dual completions have been made using 4½-in. OD casing in many areas, reduced tubing sizes and annular clearances may involve problems if waxy crude is produced, or if friction losses materially reduce annular natural gas production.

Maintaining low-angle deviation. It is more difficult to maintain a 2 or 3 deg deviation in 6¼-in. hole than in 8¾ or 9⅞-in. hole because of limitations on drill collar sizes. Drill collars in the 4¾ to 5-in. OD range in 6¼-in. hole will tend to exaggerate any normal crooked hole tendency, as compared to relatively good stabilization with 6¼-in. OD collars in 8¾-in. hole, or 7¼-in. OD collars in 9⅞-in. hole.

Round trips in 94-96 ft masts. Most slim-hole rigs now in use are limited by mast height to hoisting and racking 60-ft stands. While many factors influence round trip time, the rig that can rack 90-ft stands will, generally speaking, make faster round trips.

Directional drilling. Although at least one major California operator has drilled 6¼-in. directional slim holes and has successfully demonstrated that their completion is feasible, very little information is available at this time.

Summary

The proper development of marginal producing zones and the evaluation of many wildcat or semi-wildcat structures in California can be cheaply and efficiently accomplished with slim-hole equipment if the following conditions exist:

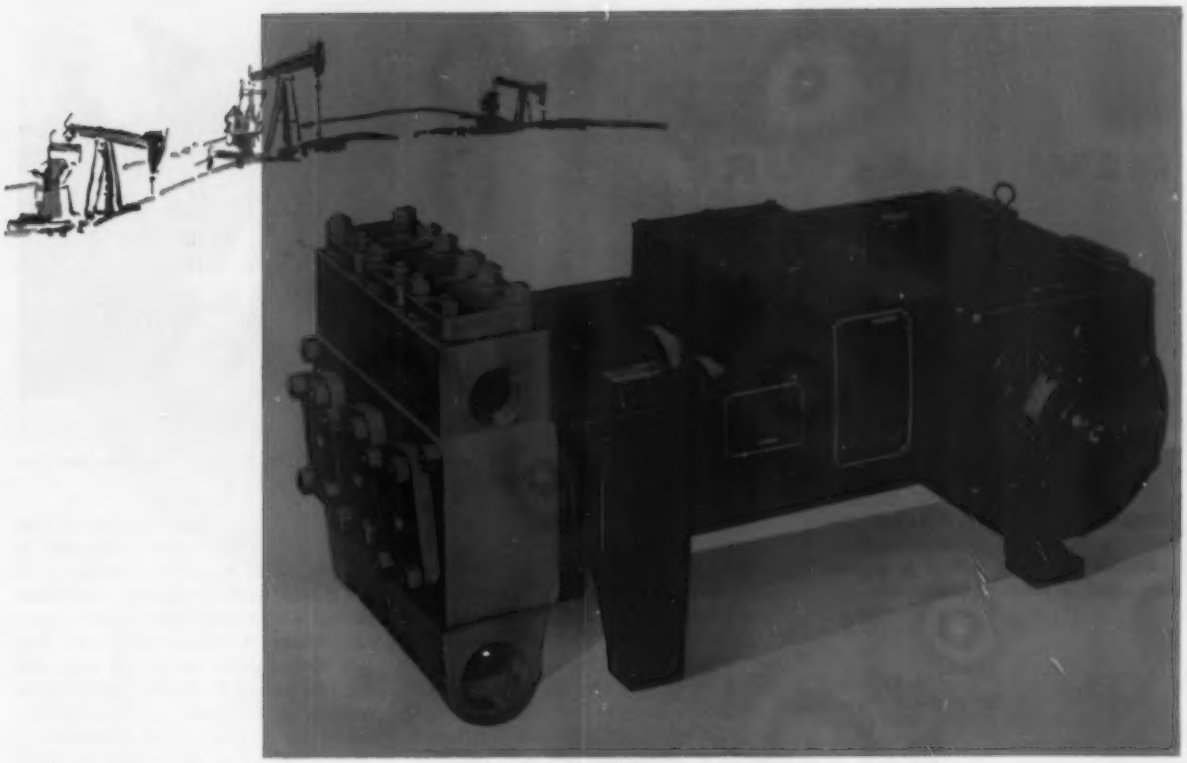
A. Programmed well depth is not beyond range of available equipment.
B. Formations to be penetrated should not be extremely hard.
C. No serious hole deviation tendencies expected.
D. Expected hole conditions do not require protective casing strings.
E. Drilling rig selected is highly mobile, operates with a minimum crew, is designed for fast rigging up, tearing out and has adequate pump, mud system and drill string for maximum efficient hydraulics.

ABOUT THE AUTHOR

B. A. "Barney" Aggers is California Drilling Manager for Santa Fe Drilling Company with headquarters in Whittier. A native of Oklahoma, where he spent his early years in Oklahoma City and Tulsa, his family moved to Southern California in 1934 where he received his secondary education in Long Beach and Compton schools. He enlisted in the U. S. Air Force in 1942 and served as navigator-bombardier instructor in New Mexico and Kansas until his honorable discharge in 1945. After receiving his bachelor's degree in petroleum engineering from the University of Southern California in 1950, he gained valuable production and drilling experience with the Union Oil Company of California. He joined Santa Fe Drilling Company in 1954 as a petroleum engineer and was responsible for California drilling contracts until his recent promotion in February 1960.

Got Any Slimhole Ideas?

A very close look is being given slimhole drilling. Bit life, hydraulics and "unmatched" surface drilling equipment are some of the present limitations for realizing benefits comparable to those realized in slimhole completions. In the October 1960 issue, *The Petroleum Engineer* presented on page B-60 a practical appraisal of slimhole drilling and a fresh approach to the economical selection of hole size. Believing that there is wide-spread interest, your editors are searching for additional constructive information on all aspects of slimhole drilling. Do you have any new ideas, performance data, methods or observations on the subject? If so, please write: J. E. Kastrop, The Petroleum Engineer, P. O. Box 1589, Dallas 21, Texas. ★ ★ ★



"Oilwell's" 3-inch stroke plunger pump is just right for small waterfloods!

The A-323 Triplex Plunger Pump is of sturdy, horizontal, three-cylinder, single-acting construction. It is specifically developed for small waterflood and salt water injection programs.

Compact aluminum-bronze fluid end is designed with double suction and discharge connections. Removable stuffing boxes accommodate plunger sizes from 1¼ to 2½ inches for working pressures from 3,000 to 815 psi. It is equipped with stainless steel plate-type valve service with nylon or stainless steel discs.

The power end is a high-strength cast-iron frame with integral cross-head guides. Crankshaft is mounted in shim-adjustable tapered roller bearings.

You can get more information about this 3" stroke, 50 hp plunger pump, including specifications and performance data, at your nearest "Oilwell" store or from your "Oilwell" representative.

USS and "Oilwell" are registered trademarks

USS **Oil Well Supply Division of United States Steel**

Executive Offices—Dallas, Texas
Export Offices—30 Rockefeller Plaza, New York 20, N. Y.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW FRACTURE PROPPING PROCESS USES ALUMINUM PELLETS

Adding aluminum pellets manually in early West Texas frac job.

Substantial increases in sustained productivity have been attained by using malleable aluminum pellets as a propping agent in fracture treatments

J. E. KASTROP,
The Petroleum Engineer
Dallas, Texas

A NEW IDEA in propping agents has been researched and developed by the Atlantic Refining Company's Research Laboratories, Dallas, Texas, and Pan American Research Laboratories, Tulsa, Oklahoma. The process employs small malleable aluminum particles, called "Frac Shot" by Reynolds Metals Company, makers of the specially-sized pellets. Purpose of the aluminum pellets is to increase the fluid conductivity within the facture or small crack created in the oil and/or gas producing formation by hydraulic fracturing. The malleable aluminum pellets resist crushing from the high loads imposed when the formation closes together upon release of the fracturing pressure. Due to the malleable nature of the aluminum particles, they will deform slightly thereby increasing the particle bearing area against the walls of the fractured formation. This increased bearing area tends to reduce the particle penetration into the formation, thereby retaining a wider crack or fracture.

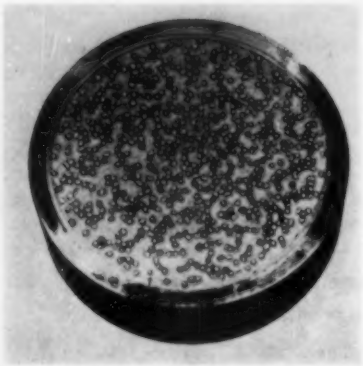


FIG. 1a

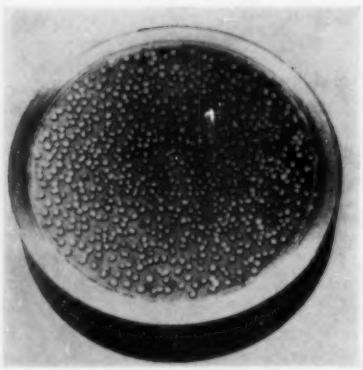


FIG. 1b

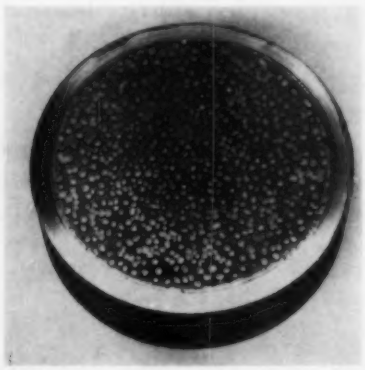


FIG. 1c

FIG. 1. **What happens to aluminum pellets under loading:** 1-A is a partial monolayer with no loading; 1-B after 2450 psi loading (3500 ft depth); and 1-C after 7000 psi loading (10,000 ft depth) shows some flattened but no crushed particles.

Fig. 1 shows what happens to the aluminum pellets when subjected to various loads. A partial mono-layer of the 12-16 mesh malleable aluminum pellets was placed between two pressure plates of a hard limestone. Fig. 1-A shows what the pellets look like with no load. 1-B shows a slight deformation of the pellets after being subjected to a load which simulates a 3500-ft well. Fig. 1-C shows the effect of the load expected in a 10,000-ft well upon the aluminum. Note that there is a definite flattening effect, but none of the particles are crushed.

The research projects, headed by Loyd Kern, supervisor of Atlantic's fracturing research, and C. R. Fast, Pan American group supervisor, showed that where high-conductivity fractures were required, the aluminum propped fractures have given better well stimulation results than field experience showed was to be expected by conventional fracturing methods.

It is not necessary . . . nor desirable . . . to completely pack a crack or fracture with the aluminum particles. Research has indicated that the crack conductivity is the product of the width of the packed fracture and the effective permeability of the propping material in the crack. This effective permeability is much greater when the propping particles are sparsely distributed . . . that is, less than a fully packed, single layer. Even though the width of the final crack (once the fracturing pressure has been relieved) may be less for the sparsely distributed particles than for the densely packed fracture, reservoir fluid can flow more easily through the sparsely packed fracture than through the densely packed fracture. Therefore, the object in using the new malleable aluminum pellets is not to form a dense pack but to distribute

There's good material and plenty of it in these packing elements. (Note the big holes—big because the packer bores are big and unrestricted.)

How to make a dual-string hookup that works

Required: a dual packer that works

NOTHING DEFEATS THE ECONOMICS of a dual completion like a dual packer that leaks. You must have a positive and dependable packoff.

It's fundamental—to make a dual string hookup work, you must have a dual packer that works, one that packs off and holds. That, many operators state plainly, is the reason they are using the new Baker duals.

WHAT MAKES THE PACKOFF SO POSITIVE? The reasons are designed into the simple and rugged 3-element packoff mechanism you see in the pictures.

There's been a lot of favorable comment on this design. It holds so well it doesn't need the non-retractable metallic backup rings that so often stick to the casing and defeat retrievability. The 3-element concept came out of a tough proving ground. It was adapted from Baker's high-performance retrievable squeeze packers, proved in thousands of high pressure downhole operations.

BUT WHEN YOU'RE MAKING THE HOOKUP, you discover that while a positive packoff is essential, it isn't everything. You must have flexibility, too.

When you want to space out, to test packers before displacement—that's when you discover the importance of a packer that offers repeat setting.

A BAKER SNAP-SET DUAL is one packer that gives you both pressure holding power and flexibility. You set and pack off by setting down minimum weight—and the packer holds. You release by picking up.

It's just that simple. You don't pressure, you don't rotate, you don't drop balls—and you don't come out of the hole to re-cock.

You set and unset as many times as you need to. And when your hookup is made, you've got one that works.

TWO BASIC MODELS

Model J (Product 756-J) is long-string set. Model K (Product 756-K) is short-string set. Both come with or without hold-down buttons (double or single grip). The picture shows double-grip Model J.

BAKER SNAP-SET DUAL PACKERS

BAKER OIL TOOLS, INC.

HOUSTON LOS ANGELES NEW YORK

49 PAGES OF FACTS

With big pictures and few words, a new brochure tells the interesting engineering facts about Baker's new Snap-Set Dual Packers. Get it from Baker representatives, or write to Baker Oil Tools, Inc., P.O. Box 2274, Terminal Annex, Los Angeles 54, California.

them in the crack as sparsely as possible, yet provide adequate propping.

Frac Fluid Concentrations

The question that might justly be asked at this point is: "How can you tell how much of the aluminum pellets to use for optimum packing of the fracture?" So far, research has provided a guide . . . or at least a starting point. Beyond this, the final and best concentration to use for optimum packing will be determined by field results in a given area and a given formation.

But, Fig. 2 shows the results of Atlantic laboratory studies on conductivities of fluid through a crack that had been packed with the aluminum pellets at various concentrations. For this study, the aluminum pellets were placed between two steel plates and a given force applied. The fluid conductivity at each concentration was measured by special apparatus after the application of 3000 lb per sq in. of load and after 7000-psi load. The results are shown by the dashed curves in Fig. 2. It is interesting to note that for this lab study involving the use of two steel plates, a plateau on the fluid conductivity curve is reached at a concentration of about 2 lb per gal (in the fracture). A higher concentration than this amount does not appreciably increase fluid conductivity. In fact, at a higher concentration the fluid conductivity decreases because the particles begin seriously interfering with fluid flow. Note also the decrease in crack conductivity due to increasing the load on the aluminum pellets. Results in Fig. 1 clearly indicate that the pellets do flatten, permitting the crack to become smaller, thereby reducing the crack conductivity.

Now . . . what happens when a soft formation is used instead of the steel plates? Results for this . . . where a Hoxbar sandstone was used instead of the steel plates . . . are shown by the solid curve on Fig. 2. Just as in the preceding investigation, different concentrations of the aluminum pellets were used. Shown are results for a load of 3000 psi. By comparing the 3000-psi load curve on soft sandstone with that of the steel plates, the effect of indentation can be demonstrated. Note that there is a drop in crack conductivity in the Hoxbar sandstone example at 3000-psi load as compared to the steel plate test at 3000-psi load. This clearly indicates that the aluminum pellets are being embedded into the sandstones. Of course, there is no embedding in the hard steel plates . . . only a slight deformation of the pellets.

This research study provides some interesting clues upon actual field use: (1) a guide to what concentrations to use; and (2) when and where to use higher or lower concentrations.

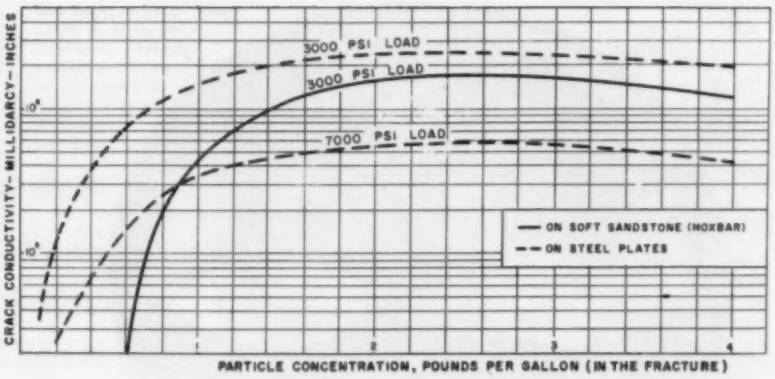


FIG. 2. **Formation hardness and particle concentration** do affect crack conductivity. Dashed curves show results of tests with steel pressure plates; solid curve show results with pellets at various concentrations between soft sandstone beds. These results show effect of deformation of the aluminum particle as well as that of embedding into the formation wall.

It is clearly indicated from the curves that the harder the formation the less concentrations need be used for an effective increase in crack conductivity. If the formation to be treated is soft, the concentration should be greater.

The range of concentrations is from about one-half pound per gal to 4 lb per gal. Several field tests to date have used from one-half to 2 lb of the aluminum pellets per gal of fracturing fluid. The first field trial used a total of 6900 lb of the pellets; the average treatment will require about 3000 lb.

Aluminum Particle Size

In the development and field trial stages, the aluminum pellets were made in two size ranges: (1) 8-10 mesh, or approximately 0.095 in diameter; and (2) 12-16 mesh, or about 0.065 in diameter. In commercial application, the range of the larger particles will be extended to include 8-12 mesh.

The laboratory studies indicate that the larger size is more effective than the smaller size. However, during the development period the small size has been used in some hard formations, where the crack width was expected to be small. The use of the small size in soft formations has usually been avoided because of the severity of particle embedment.

Use as a Spearhead

Practice to date in the use of aluminum pellets as a propping agent has been to employ a spearhead treatment ahead of the pellets. Purpose of this spearhead of fluid is to initiate the fracture and plaster the walls of the cracks to control fluid leak-off. The spearhead fluid usually contains adequate amounts of leak-off control agents successfully used in conventional fracture treatments. By controlling leak-off of the spearhead fluid, the concentrating of propping material in the fracture from loss of carrier fluid is minimized.

Carrying Fluids

It is desirable to suspend the pellets so that sparse propping can be achieved in the crack. The fluid that actually transports the aluminum pellets into the fracture should have a higher gel strength than those fluids normally used with sand. Reason is that the pellets are much larger in size than the sand generally used (20-40 or 40-60 mesh) and are more difficult to suspend. The usual carrying agents have been used successfully . . . such as gelled water, diesel oil, kerosene, etc. Water-in-oil emulsions also have been used with success.

The gel strength has been increased so as to completely suspend the pellets in a static solution. For this reason, concentrations of the gelling agents in the carrying fluid have been doubled and even tripled over that concentration normally used in conventional treatments with sand.

Injection Rates

The rate of fluid injection should be high to hold the crack open by hydraulic pressure, to minimize the effects of gravity, and to minimize the effects of leak-off. A high relative rate of leak-off will concentrate the propping agents in the crack, a result which is undesirable in this process. In field practice, it is desirable to inject the carrying fluid with aluminum pellets at a rate of at least 6 to 8 bbl per min. Of course, we know from past fracturing experience that high injection rates in general establish downhole conditions more favorable to a successful job.

No Overflush

Since the objective of this process is to provide an optimum distribution

McCULLOUGH SALINITY LOG

with scintillometer®

...a nuclear log that tells

OIL *from* SALT WATER

The McCullough Salinity Log determines the presence and degree of saline fluids in formations surrounding the bore-hole. It will distinguish between oil and salt water and can be used in open or cased hole. Providing hole diameter is not extreme, it may be used where air or gas or highly saline fluid was used for drilling.

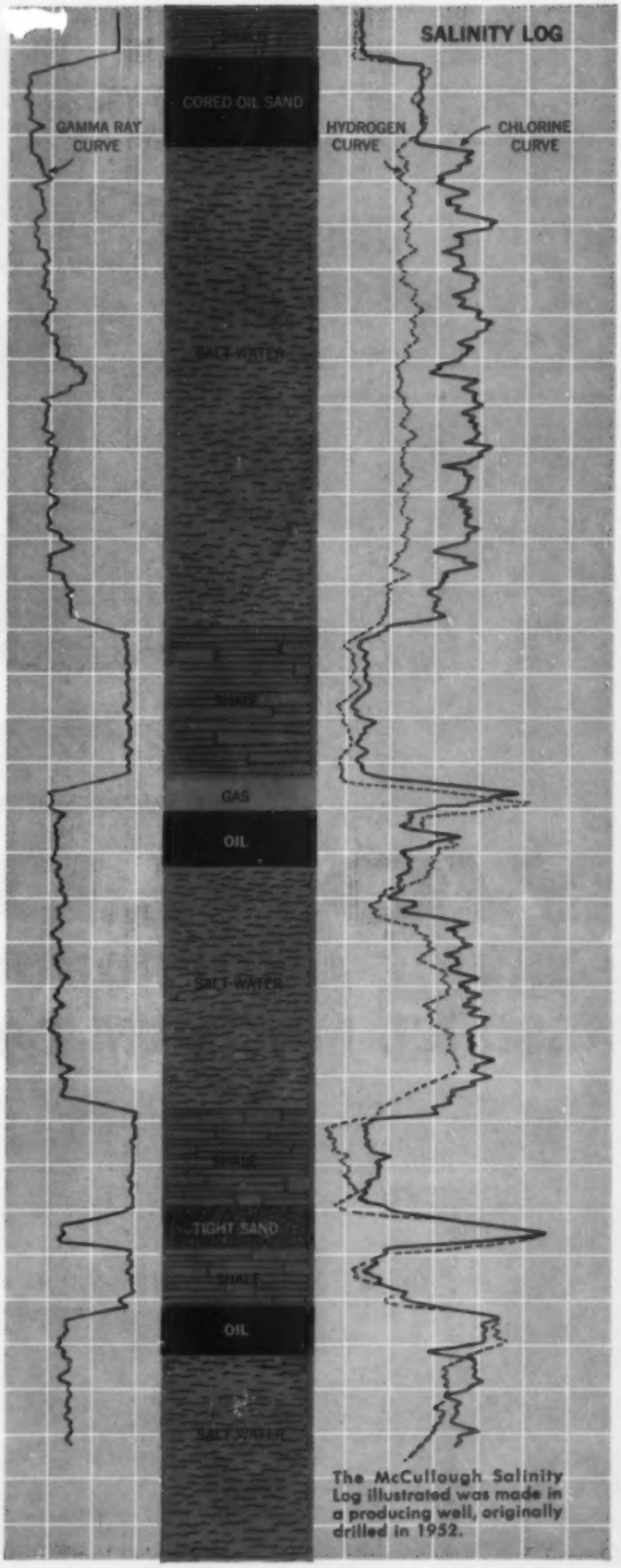
A "chlorine" curve and a "hydrogen" curve are recorded simultaneously at the same depth elevation with a single detector. These curves are compared to indicate the amount of salt, NaCl in particular, that is present in the formations being investigated. In potential oil bearing formations the absence of salt is indicative of the presence of oil.

The recording of the two curves simultaneously is considered essential. It eliminates the possibility of a depth discrepancy between two curves which are recorded separately. It also insures the recording of information under identical physical conditions—of extreme importance in interpreting the two curves.

A higher counting rate and greater instrument efficiency allows an increased spacing (23½ in.) between the source and the Scintillometer. This provides the added benefit of a proportionately larger zone of investigation.

Take a look at these features:

- **Distinguishes between salt water and oil in liquid bearing formations.**
- **Determines the degree of salinity in formation fluid.**
- **Identifies salt water zones that must be blanked off.**
- **Makes possible water saturation calculations for potential oil bearing zones.**
- **Shows salt water and oil zone contact under suitable conditions.**
- **Aids in determining gas/oil contact.**
- **Helps determine if it is economically practical to set casing on new completions.**
- **Aids in evaluating correct depth to set casing string.**
- **Accurately re-evaluates old wells to locate potential cased-off production.**
- **A reliable tool for porosity determination.**



The McCullough Salinity Log illustrated was made in a producing well, originally drilled in 1952.

McCullough

TOOL COMPANY

Los Angeles • Houston • Edmonton

Cable Address: MACTOOL

WHEREVER IN THE WORLD YOU DRILL FOR OIL..

Security

WORLDWIDE

SERVICE AND PRODUCT SUPERIORITY ASSURES MAXIMUM DRILLING ECONOMY

SUPERIOR SERVICE is provided through worldwide teamwork plus painstaking selection of topflight representatives, agents and field engineers — specially trained in knowledge of worldwide drilling requirements and Security's qualifications for satisfying all your drilling needs. *Get Security in YOUR drilling!*

HIGH UNIFORM BIT QUALITY is assured through identical Security standards of design, engineering, metallurgy, production techniques, dimensional precision, and performance characteristics — whether manufactured in Manchester, England... Whittier, California... or Dallas, Texas. *Write for 1960-1961 Security catalog.*

Write for new 1960-1961 All-Products Catalog.

Security

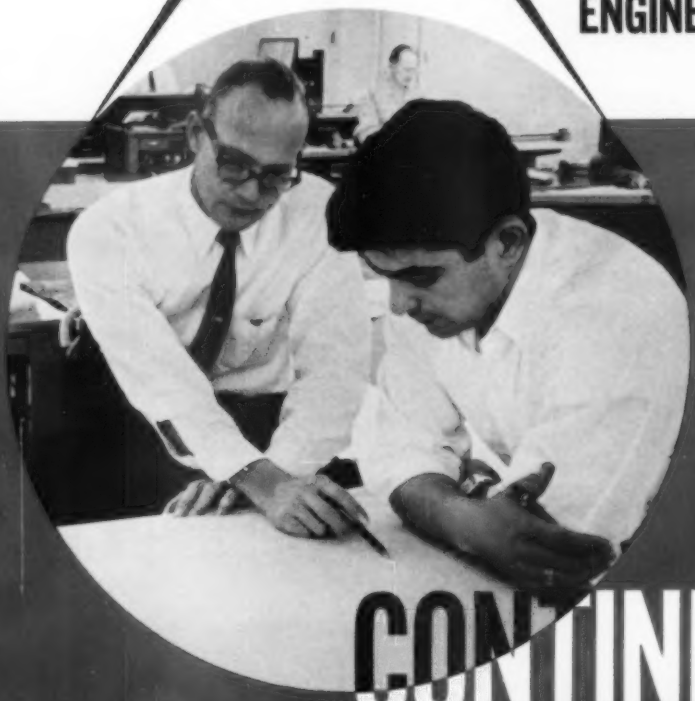
ROCK BITS
REAMERS • HOLE OPENERS
STABILIZERS • CASING SCRAPERS

DRESSER INDUSTRIES INC.

OIL • GAS
CHEMICAL
ELECTRONIC
INDUSTRIAL

PLANTS... Dallas, Texas; Whittier, California; Manchester, England
SECURITY ENGINEERING DIVISION... 3400 W. Illinois, Dallas, Texas
EXPORT OFFICE... Post Office Box 13647, Dallas, Texas
CANADA... Security Engineering Canada, Ltd., Edmonton, Alberta, Canada
OVERSEAS... Security International C. A., Caracas, Venezuela; London, England

THROUGH
ENGINEERING DESIGN..



CONTINENTAL-EMSCO SLUSH PUMPS CUT DRILLING COSTS

LOWER WEIGHT cuts transportation costs . . speeds handling at well site. Extra metal thicknesses are placed only where they are needed in critical areas in the frame. This is the secret of FABRIFORM construction, originated and developed by C-E engineers. It is based on a *sound* engineering method of welding steel shapes, plates and small castings into a strong single unit. Gone are the bulky, hard to handle castings with their excessive weight. Precision machining of the power end frame assures accurate alignment of main shaft, pinion shaft and crosshead bores. All machining operations take place after the power end frame has been completely stress relieved. Fabricated steel fluid ends provide maximum strength and also reduce weight.

NARROW PUMP DESIGN eases handling, requires less premium space on offshore installations. The use of an eccentric design makes a narrow, compact power frame possible. One-piece steel eccentric hub with gear mounting, eccentric and main shaft integral add to the compactness of Continental pumps.

HIGH EFFICIENCY maintained by fluid end design. Suction passages are large, direct and smoothly curved to prevent restrictions of fluid flow, even when pumping heavy drilling muds. Use of one suction opening eliminates *dead spaces* which tend to break up a streamline flow.

POWER END

1. Steel Skids—Wide Independent Skids on Larger Pumps . . Skids Integral with Frame on Smaller Pumps
2. Replaceable Crosshead Guides
3. Replaceable Meehanite Crosshead Slippers (On Larger Pumps) Cast Meehanite Crosshead on Smaller Pumps
4. Controlled Splash Lubrication on Smaller Pumps. Controlled Splash and Pressure Lubrication System on Larger Pumps
5. One-Piece Connecting Rods, Equipped with Large Diameter, High-Capacity, Retained-Type Roller Bearings
6. Roller Bearings Used Throughout
7. All-Steel FABRIFORM Construction
8. Demountable Forged-Steel Herringbone Gear
9. One-Piece Forged-Steel Pinion and Shaft
10. Packing Gland and Rubber Baffle to Protect Power End from Mud
11. API Tapered Thread Fluid Rods

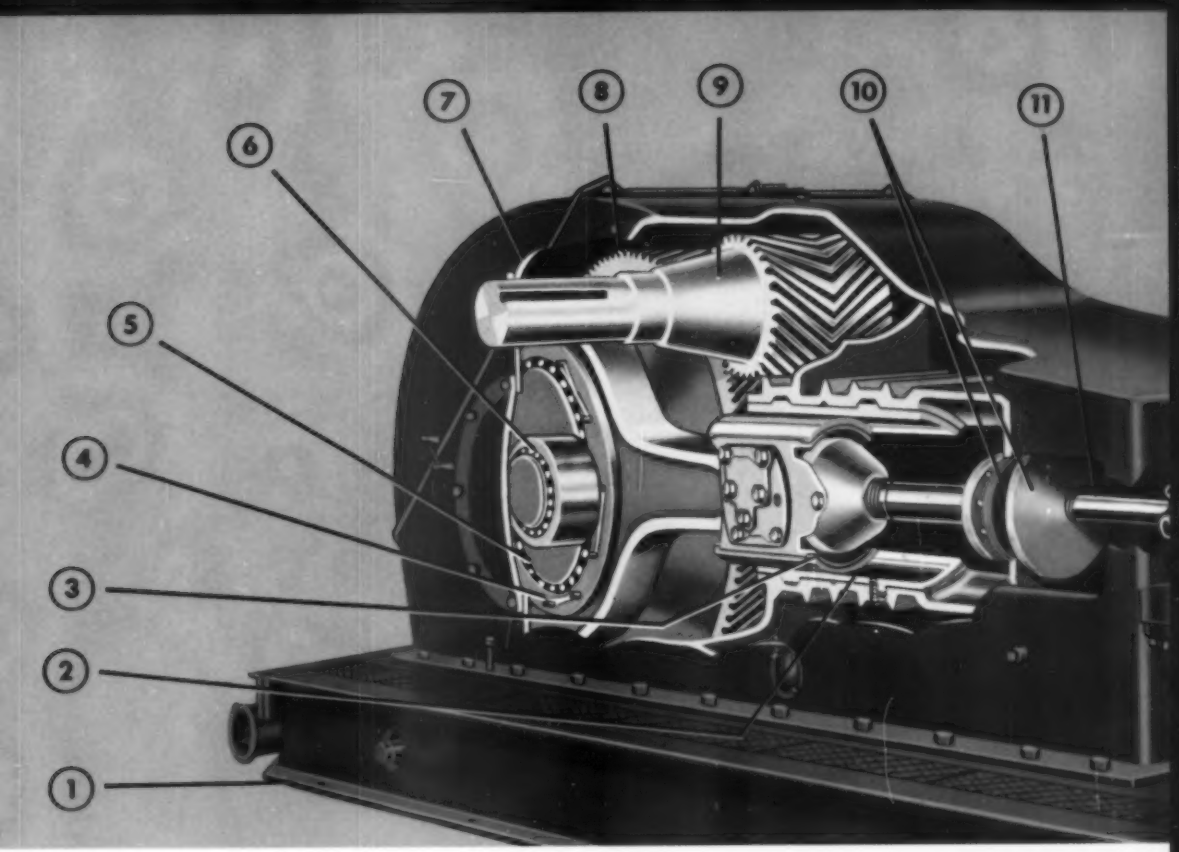
FROM POWER END TO FLUID END EACH FEATURE

HERRINGBONE GEAR TRAIN provides dependability and strength. Continuous tooth design keeps the gears running smoothly and quietly. Forged-steel, heat-treated ring gear is demountable. Pinion and pinion shaft are integrally forged of high alloy steel and fully heat treated for maximum strength and wear. The resulting enlarged diameter assures stiffness and rigidity, minimizing deflection. Roller bearings reduce friction and increase service life.

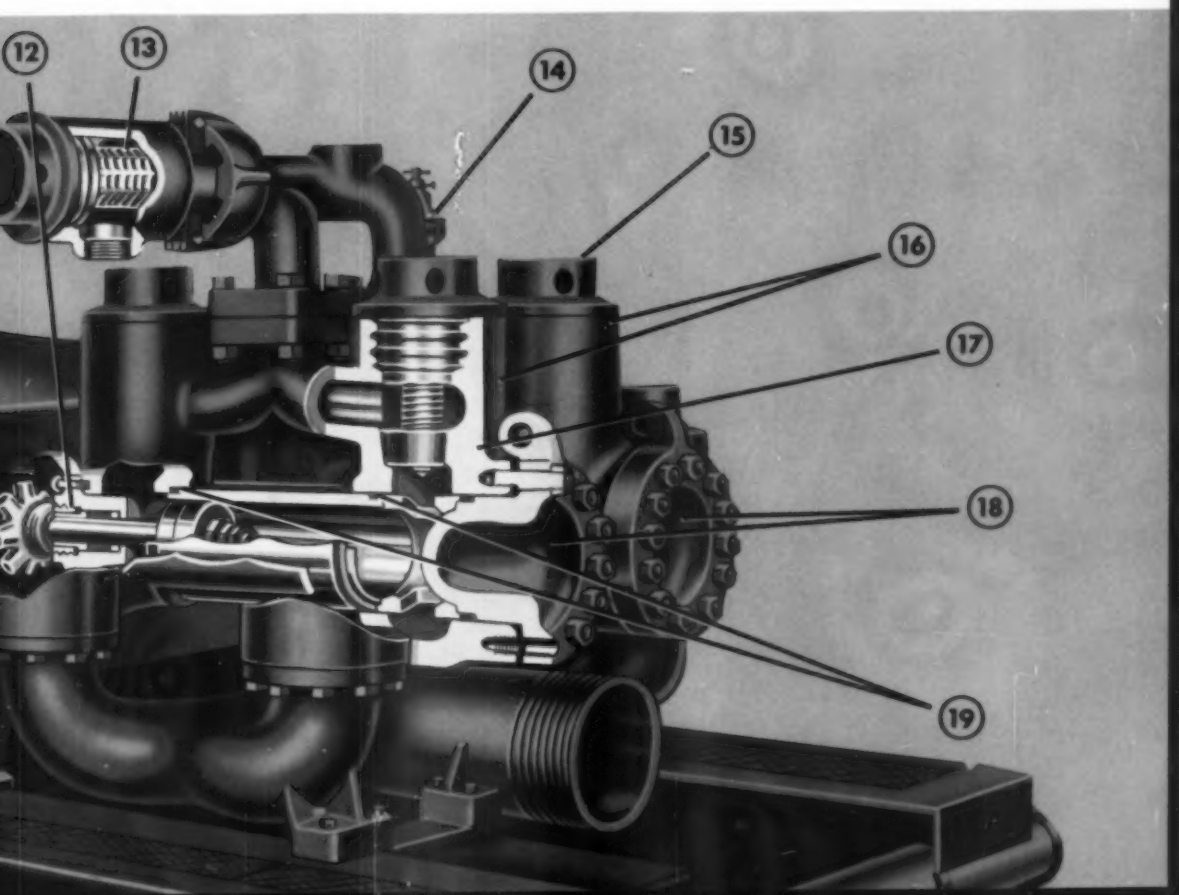
SIMPLIFIED MAINTENANCE FEATURES reduce downtime. Patented "exposed liner" design makes it possible to spot the slightest leak as soon as it occurs. Packing can be tightened or replaced before a costly washout occurs. It also prevents the liner from "sanding-up" in the cylinder bore. Screw-type stuffing box glands provide uniform pressure on the piston rod packing to eliminate uneven packing wear and scoring of piston rods. Threaded valve pot covers handle the highest pressures, yet make valve servicing fast and easy. Heavy, coarse threads on valve covers make them trouble-free, simple and quick to open. API tapered thread fluid rod connections provide fast and easy rod changing. Crossheads operate in replaceable guides. On the larger pumps, the crossheads are fitted with replaceable Meehanite slippers. On smaller pumps, the crossheads are made of cast Meehanite. Pumps are completely oil lubricated to simplify maintenance and safeguard performance.

FLUID END

12. Screw-Type Stuffing Boxes
13. 360° Swiveling Discharge Connection on larger pumps . . Threaded Cover for Easy Access to Screen
14. Shear Relief Valve . . Standard Equipment
15. Heavy Coarse Pitch Threaded Covers Screw Directly Into the Valve Pot . . Easily Removed by Inserting a Bar in Holes and Turning
16. Fabricated Steel Fluid End—Four Piece on Larger Pumps . . One Piece on Smaller Pumps
17. API Valve Pot Dimensions
18. Liner Retaining Cylinder Heads, Eliminates Troublesome Liner Lock Bolts
19. Liners Packed at Both Ends and Exposed to View to Spot Leaks

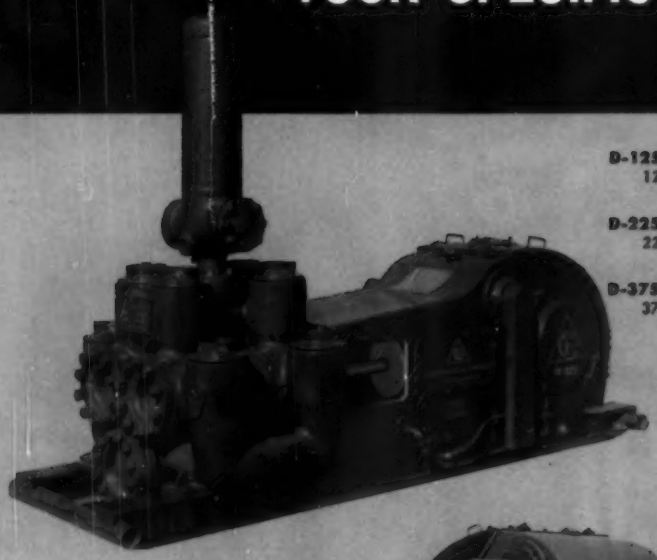


RE IS DESIGNED TO LOWER DRILLING COSTS



THERE'S A CONTINENTAL-EMSCO SLUSH PUMP FOR EVERY JOB

PICK THE ONE RATED FOR YOUR SPECIFIC NEEDS

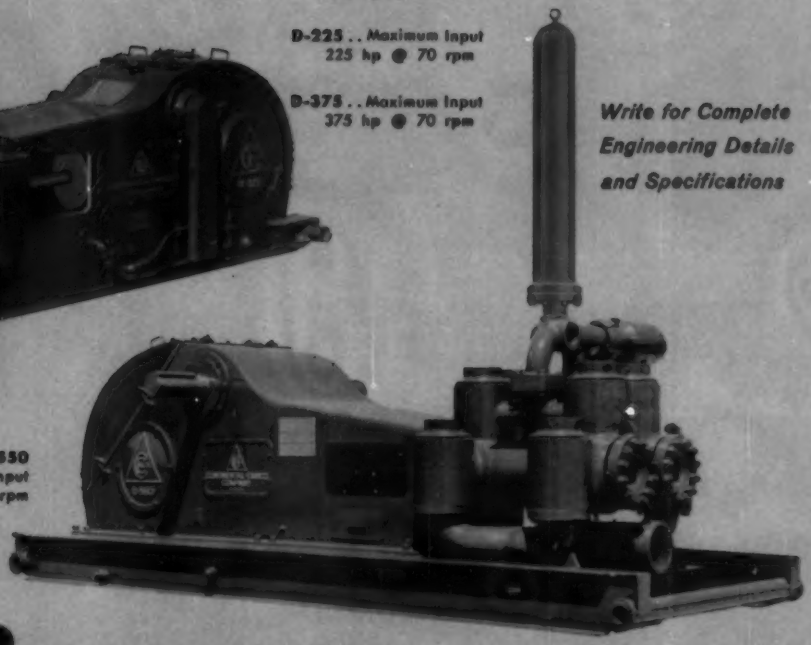


D-125 . . Maximum Input
125 hp @ 85 rpm

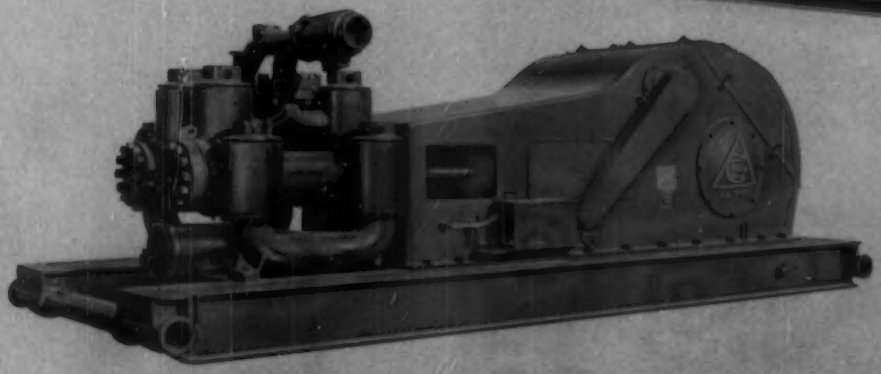
D-225 . . Maximum Input
225 hp @ 70 rpm

D-375 . . Maximum Input
375 hp @ 70 rpm

Write for Complete Engineering Details and Specifications



D-550
Maximum Input
550 hp @ 65 rpm



DA-700 . . Maximum Input
700 hp @ 65 rpm

DA-850 . . Maximum Input
850 hp @ 60 rpm

D-1000 . . Maximum Input
1000 hp @ 60 rpm

MANUFACTURED AND SOLD WORLDWIDE BY

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

CONTINENTAL-EMSCO COMPANY • A Division of The Youngstown Sheet and Tube Company • General Offices Dallas, Texas
Export Division 30 Rockefeller Plaza, New York, N. Y. • Continental-Emsco Company Limited • General Offices Calgary, Alberta, Canada
Continental-Emsco Company C. A. Caracas, Venezuela • Plants Houston and Garland, Texas; St. Albans, Herts., England • Representatives in All Principal Oil Fields of the World

JSP 020
PRINTED IN U.S.A.

Quality Must Be Preserved If Performance Is To Be Assured

. . . and the final proof of quality in sucker rods is how well they perform in the well.

That is why LIBERTY MANUFACTURING COMPANY of Texas spares no effort or expense to assure producers everywhere that Liberty Sucker Rods arrive at the well site in the same excellent condition as when they left the inspection line at the plant.

This is accomplished by attaching rubber thread protectors both to the pin ends and coupling ends of the rods. These protectors are color coded for easy identification of rod types. They afford genuine shock resistance, will not vibrate loose during transit, and are quickly removed without hammering as the rods are made up to go into the well.

Palletized Packaging is available upon request at no additional charge. This type of packaging cuts handling costs and insures the delivery of straight rods to the well.

The careful preservation of quality in LIBERTY Rods is reflected in longer, trouble-free performance in the production string. For in all operations, from manufacturing to safe delivery, the goal at LIBERTY is not to produce the most sucker rods in the least time, but to produce the finest sucker rods . . . regardless of time!

FOR EXCELLENT PRODUCTS AND SERVICE
SPECIFY LIBERTY SUCKER RODS AND PUMPING UNITS

• SOLD ONLY THROUGH SUPPLY STORES •

LIBERTY
MANUFACTURING COMPANY OF TEXAS
4025 Hemphill Street • Fort Worth, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

of the aluminum pellets within the fracture for the highest fluid conductivity possible, this distribution should not be disturbed once established. If an overflush is used, the suspended pellets will be washed back away from the wellbore. For this very important reason, no overflush is recommended.

Formation Hardness

To design a fracture treatment using aluminum pellets it is necessary to know as accurately as possible the hardness of the formation to be treated. As demonstrated in Fig. 2, hardness has a great deal to do with the concentration of pellets used. If the formation to be treated is quite hard, it is possible to use as little as one-half lb per gal of pellets of gelled fluid. For softer formations, tne concentration should be greater . . . and the larger sized particles used.

Typical Treatment

Although the actual treatment will be determined in large part by the interval and characteristics of the formation to be treated, a typical treatment . . . as determined by field tests to date . . . might be 20,000 gal spearhead . . . followed by about 2000 lb of the aluminum pellets in a gelled fluid. This typical treatment would probably employ pellets of an 8-12 mesh size.

Some Field Results

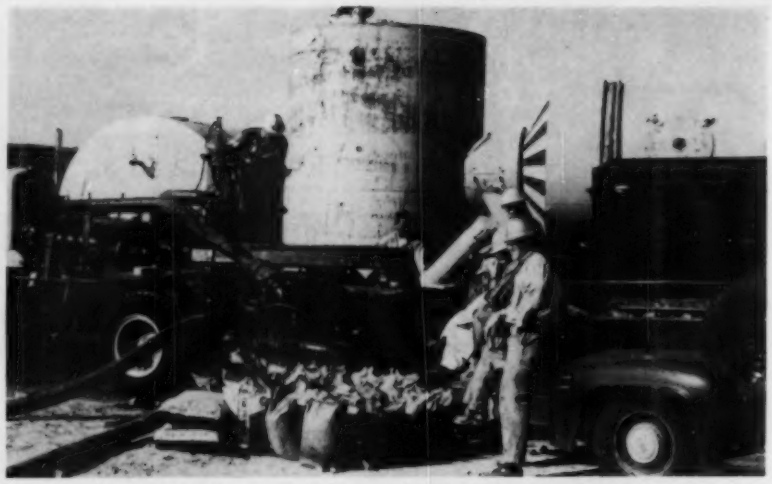
Although the process is still in the development stage, results from several field treatments have been very encouraging. One well in the Salemsborg field near Great Bend, Kansas, was completed with five ft of perforations at 3438 ft in the Maquoketa (dolomite) formation. It had been treated with 2000 gal of acid and previously fractured with 5000 lb of 20-40 mesh sand in 5000 gal of heavy oil. Productivity had been improved somewhat.

Later, the well was re-fractured with 17,500 lb of 20-40 mesh sand in 20,000 gal of oil followed by 500 lb of 8-10 mesh aluminum carried in the well by 5000 gal of gelled fracturing oil.

The average injection rate was about 32 bbl per min. Sustained production of the well increased 300% following the refracture treatment.

For a conventional sand re-fracture treatment of similar size, no more than a 60 to 70% increase would have been expected in this area.

Why should such a small quantity of the aluminum pellets bring about such a large increase in productivity? In the concentration used, the aluminum pellets were capable of supporting 30-40,000 sq ft of fracture. This is equivalent to a propped height of 100 ft and a fracture radius of 150 to 200 ft.



Aluminum pellets in 50-lb bags used in frac job in Southwest Texas.

In another field test in the Hagist Ranch field of Duval County (Southwest Texas), a well was completed in the Wilcox (sandstone) formation at about 7000 ft with a 30-ft perforated interval. It had not been acidized or fractured previously.

The well was fractured with 13,000 lb of 40-60 mesh sand carried into the formation at one-half lb per gal by an emulsion fluid. This treatment was followed by 4500 lb of 12-16 mesh aluminum pellets in 2500 gal of water-in-oil emulsion. Injection rate averaged about 5½ bbl per min. Productivity increased five to six times what it was prior to treatment . . . which increase was two or three times greater than was to be expected from a conventional fracture treatment using sand as the propping material.

Use of Sand with Aluminum

Sand has been used with aluminum in the early field tests. Reason for this was that the desirable stimulation can sometimes be accomplished at a lower overall cost by using sand ahead of the aluminum rather than using just aluminum alone. Also, this combination of sand with aluminum offers a margin of safety should the fracture not open up wide enough to admit the pellets or should the aluminum become too imbedded in the fracture walls . . . or, if there is an inadvertent overflush.

Early Field Problems

As can be expected in the development stages of any new process, there were several minor problems to crop up when the process was tried in the field. One of the early problems was caused by the reaction of excess caustic in gelled oil with the aluminum. The reaction caused foaming to such a degree that the suction pumps would not operate. This problem was avoided in later tests by more careful control of the caustic.

Another problem was encountered when the aluminum pellets were carried in a water-in-oil emulsion. The treatment was pumped down with water. At the end of this treatment, some of the emulsion (and aluminum) remained in the wellbore. Since the emulsion was lighter than the water, the emulsion rose to the top as it began to break up. The aluminum pellets were carried up with it, and globules of the broken emulsion would stick to the casing wall. Presence of the pellets sticking to the casing well prevented running a production packer.

This problem was solved by using a buffer of oil between the emulsion and the water column used to pump the emulsion in place.

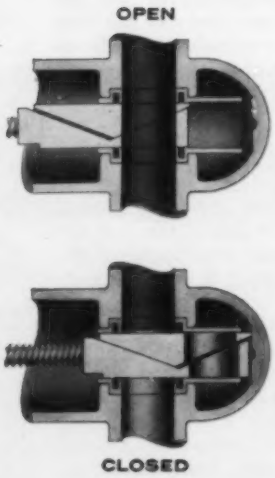
Potential of the Process

The process is now . . . or shortly will be commercially available in many U. S. oil-producing areas. The aluminum pellets and the process will be offered by four of the leading well servicing companies. It is estimated by Robert S. Edwards, manager of petroleum markets for Reynolds Metals Company, that between 30,000 and 40,000 wells will be fractured in 1960. With the encouragement thus far obtained in field treatments with the aluminum pellets, undoubtedly a good number of these wells will use this process.

Reference

"Propping Fractures with Aluminum Particles," by L. R. Kern and R. E. Wyant, The Atlantic Refining Co., Dallas, AIME paper 1573-G, presented at the 35th Annual Fall Meeting of the Society of Petroleum Engineers of AIME at Denver, Colo., October 2-5, 1960.

★ ★ ★



Get the extra margin of control in W-K-M Multiple Completion Valves

Available in no other integral multiples, the famous W-K-M Parallel Expanding Gate lets you control the *seating force* as well as the action of opening and closing.

This extra margin of control lets you close the valve to *absolute shut-off* . . . open it until the gate assembly is sealed positively against the seats for *perfect through-conduit* flow. Result: *no* turbulence to cause erosion or abrasion.

The extra protection of W-K-M Integral Multiples is the most economical production insurance you can buy.

Types: Duals to 10,000 lb.; Duals with Cross to 5000 lb.; Triples to 10,000 lb.; Triples with Cross to 5000 lb.; Quadruples to 5000 lb.

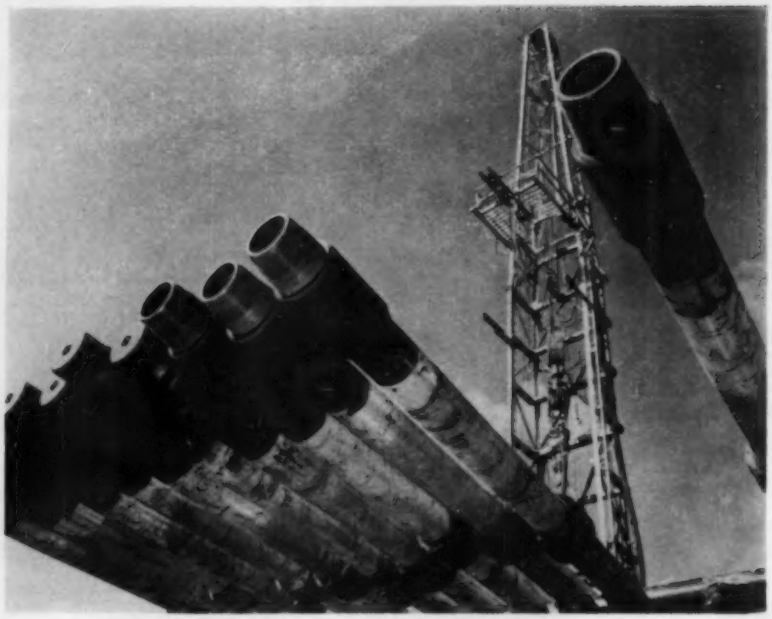
W-K-M

DIVISION OF ACF INDUSTRIES INCORPORATED

P. O. BOX 2117, HOUSTON, TEXAS

6001

ALUMINUM DRILL PIPE EXTENDS RIG DEPTH RATING



Aluminum drill pipe with special steel tool joint ready to go in 10,400-ft Southwest Texas well.

New 4½-in. upset extruded aluminum alloy pipe with special steel tool joint successfully tested by Shell Oil Company in a 10,400-ft South Texas well

SHELL OIL Company's Rig 25 drilled the Alvin F. Sievers No. 1 located in DeWitt County, Texas, to a depth of 10,400 ft. The rig's rated depth with 4½-in. steel drill pipe is about 7000 ft. This depth extension was made possible by a new 4½-in. upset extruded aluminum alloy drill pipe developed by Reynolds Metals Company and equipped with steel tool joints especially designed and fabricated by Reed Roller Bit Company.

Shrink-grip steel joints can be removed and hand-applied in the field on new aluminum drill pipe. Special joint is pre-heated to 650 to 750 F by portable heater.

Use of the pipe culminates six years of extensive experimental work and private field tests by Reynolds. The special tool joints and method of assembly were developed by Reed's research department in cooperation with Reynold's product development division.

Fatigue endurance of the aluminum drill stem and tool joint assembly has proved in lab tests to be 800,000 to 1,500,000 cycles, compared with 500,000 to 800,000 cycles for grade E steel pipe and hand applied tool joint assemblies under the same loading conditions.

Weight reduction big factor. Aluminum drill pipe weighs only about half as much as steel and for this reason the developers believe aluminum drill pipe will penetrate up to twice as deep as steel pipe before exceeding a rig's hook capacity. The 4½-in. aluminum drill pipe weighs only 8.60 lb per ft in air compared with 15 lb per ft for steel drill pipe, or a difference of almost 200 lb per 30-ft section.

This weight differential is even greater in drilling mud. For example, in a 10-lb per gal mud, a joint of Range 2 aluminum drill pipe weighs 218 lb compared to 455 lb for the same length of steel drill pipe.

Tool joint key factor. A large part of the success of the new assembly lies in the use of a new improved type of shrink-grip tool joint connection. This special joint has a cylindrical land and fixed shoulder that insures foolproof application and removal by hand in the field. When the aluminum drill pipe needs replacing, it is not necessary to send the pipe and tool joints to a shop. The joints are removed and applied in the field by hand with only the use of small portable heaters. The tool joint is heated to between 650 and 750 F. Water is circulated in the aluminum drill pipe and the tool joint is then screwed onto the drill pipe by hand. As the joint cools, the threads, shrink-grip area and gaging shoulder shrink to a predetermined tightness. This tightness, due to the shrinkage, is held within the elastic limit of the pipe to prevent deformation of the pipe end attachment elements.

Advantages claimed for the new aluminum drill pipe are: (1) ⅓ to ½ less horsepower needed to pull and run aluminum pipe (two men can carry one joint); (2) extends rig depth rating so smaller rigs can drill deeper holes; (3) more footage can be carried per truck load, thereby reducing transportation costs; (4) improved hydraulics with aluminum due to smoothness factor; (5) high scrap value . . . about $1.75 per ft; (6) ideal for whipstocking due to high fatigue life; and (7) smaller tolerance since Range 2 aluminum pipe varies no more than ½ in. per joint.

Tests to date show no signs of pitting or galvanic type corrosion. The amount of wear from abrasion has been no worse than is normally encountered with steel pipe. ★ ★ ★

"A great step forward with your Planetary Gears, Big Bearings and Cylindrical Crossheads."

— J. K. Butler

WHELAND PLANETARY
HP-16000 PUMP
Duplex Power Slush Pump
7¾" x 16", 600 H.P. at 65 RPM

OIL PRODUCTION MAINTENANCE, INC.
7440 CHOCOLATE BAYOU ROAD -- P. O. BOX 14291
HOUSTON 21, TEXAS
August 31, 1960

Mr. Gordon P. Street, President
The Wheland Company
Chattanooga, Tennessee

Dear Mr. Street:

Our Wheland Planetary Pump is giving us increased penetration and good savings on bits. We know from more than 18 months of constant operation on 10,000 Ft. wells that our savings are substantial.

We have kept an accurate record on operating costs and all maintenance costs and are especially impressed by the low cost of fluid end expendables. The HP-16000 Pump has constantly operated near its rated capacity on more than 200,000 feet of hole in the Texas Gulf Coast Area.

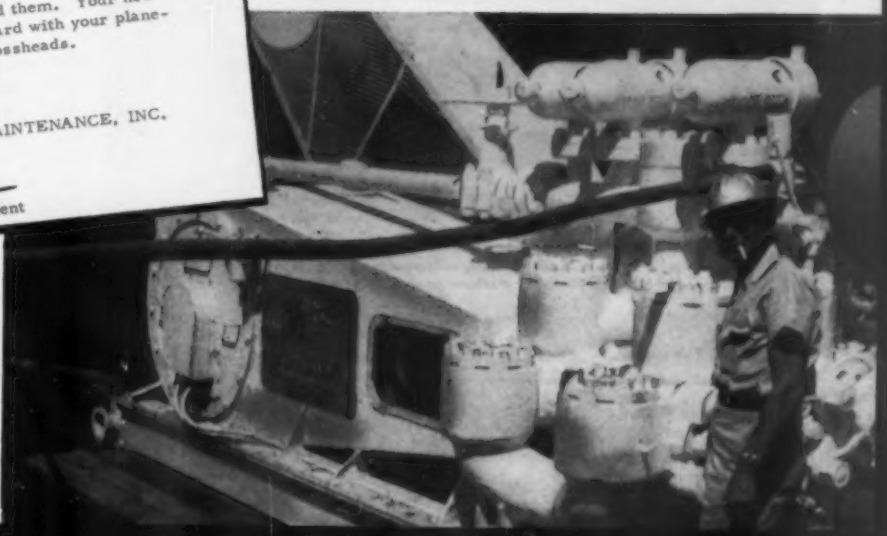
We are now operating Wheland HP-18000, HP-14000, and HP-16000 Pumps and are glad to recommend them. Your new HP-16000 Pump design is a great step forward with your planetary gears, big bearings and cylindrical crossheads.

Yours very truly,

OIL PRODUCTION MAINTENANCE, INC.

J. K. Butler

J. K. Butler, President



Wheland HP-16000 Planetary Pump owned by Oil Production Maintenance, Inc., on location in the Gulf Coast area.

WHELAND

ROTARY DRILLING MACHINERY

THE WHELAND COMPANY
CHATTANOOGA, TENNESSEE, U.S.A.

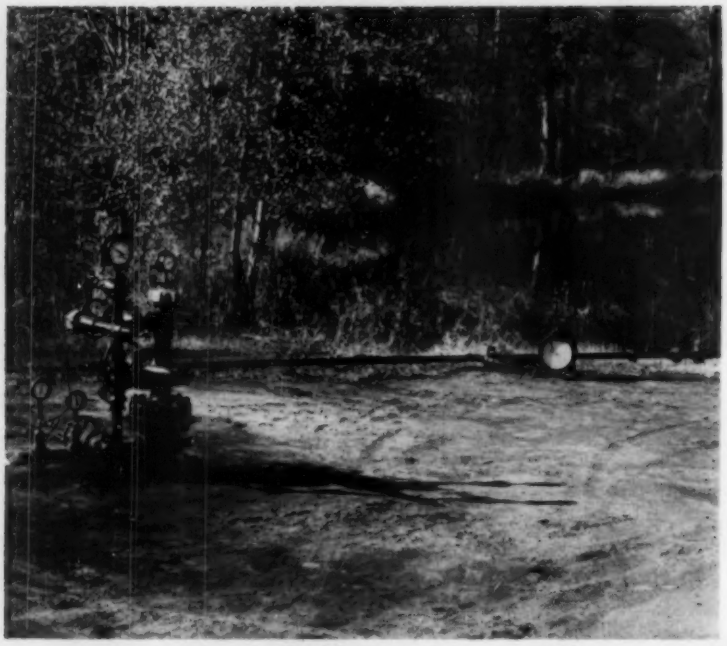
DRAW WORKS • SLUSH PUMPS • ROTARIES
CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

DOMESTIC DISTRIBUTORS: INDUSTRIAL SUPPLY COMPANY, INC.—Main Office: Wichita Falls, Texas • HOUSTON OIL FIELD MATERIAL COMPANY, INC.—Main Office: Houston, Texas.

EXPORT DISTRIBUTORS: LUCEY EXPORT CORPORATION—233 Broadway, New York 7, New York—Broad Street House, London, E. C. 2, England.

135 CU FT GAS LIFTS

LUTHER F. ELLISON, *Sun Oil Company, Dallas, Texas*

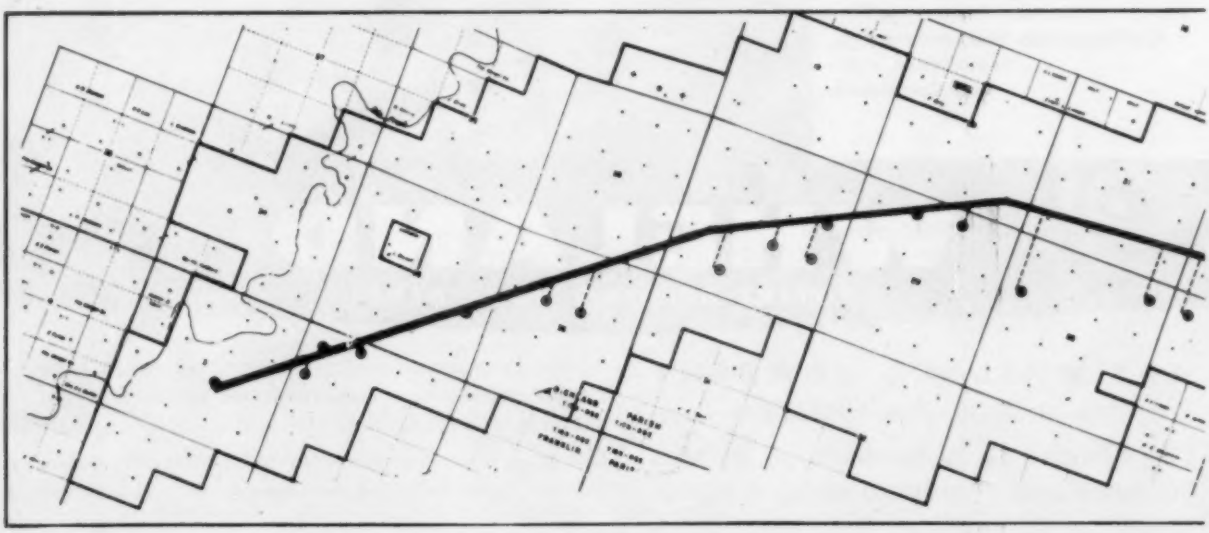


Typical gas lift wellhead hookup in the Delhi field of Northeast Louisiana where extremely high lifting efficiencies and low lifting costs have been accomplished. Portable meter measures injection gas volumes.

As nearly an ideal gas lift installation as known has been successfully installed in the Delhi field of Louisiana. Direct lifting costs average only 4.6 cents per bbl, estimated payout less than two years

UNUSUALLY HIGH LIFTING efficiencies have been achieved by a carefully engineered gas lift system in the Delhi Unit of the Delhi field located in Richland, Franklin and Madison parishes of northeast Louisiana, where Sun Oil Company is the operator. Although the system was designed on the basis of about 167 cu ft of gas per bbl of fluid produced, production data indicate that on the average, one bbl of fluid is being lifted by only 135 cu ft of gas. And . . . although a high percentage of the produced fluid is water, the direct lifting costs average about a nickel per bbl of oil.

Two-in. flow lines from three gas lift producers were enlarged to 4-in. flow lines to reduce back pressure on the



1 BBL FLUID AT DELHI

tubing. Results were more than encouraging according to recent field tests. Total fluid recovery on these three wells increased from 2114 bbl to 3574 bbl per day; oil recovery increased from 43 bbl to 334 bbl daily; and the input gas-to-fluid ratio declined from 160 cu ft per bbl fluid to 70 cu ft per bbl fluid.

About 75% of the 12-mile long by 1-to-2-mile wide productive limits will ultimately be produced from a cumulative total of about 130 gas lift wells. However, it was found that only a maximum of some 35-40 wells would be gas lifted at any one time, and this would occur around mid-1961. The current gas distribution system was designed to accommodate all future requirements.

Sun is Unit Operator

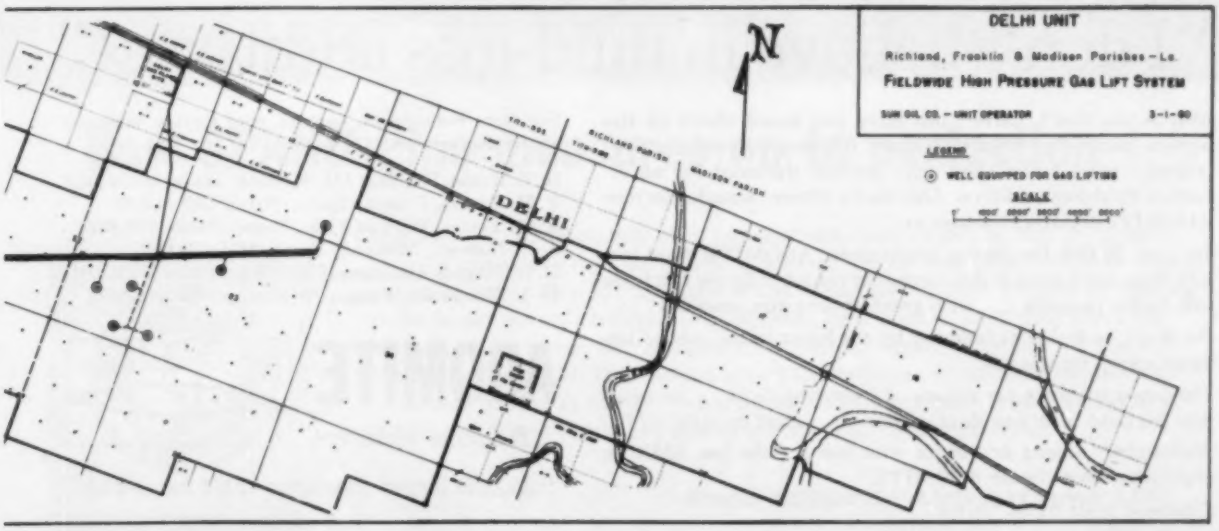
The Delhi Unit was legally established on February 1, 1953 with Sun Oil Company designated as unit operator of 257 wells within a Unit Area of about 12,000 acres, being approximately 12 miles in length and varying in width from less than one mile to more than two miles. A primary aim of unitization was to allow the initiation of a repressuring and pressure maintenance program throughout the major productive zone which is Cretaceous in age and locally named the Holt-Bryant Sand. This reservoir is a stratigraphic trap which strikes essentially east-west, dips to the south and encompasses production limits that roughly coincide with the Unit Area, a long and relatively narrow confine shown in Fig. 1. Top of the pay generally occurs between 3100 ft and 3500 ft. The pay section, although composed of stringers in some localities, is normally well developed with gross sand thickness sometimes exceeding 100 ft. As a whole, good continuity prevails and the producing potential is enhanced by comparatively high permeability, averaging about 1800 millidarcy's throughout the zone.

Basis for Gas Lift

Large-scale salt water injection was initiated on October 1, 1953 and at present the results have proved to be highly successful. During 1957, soon after it became evident that the injection program and facilities had advanced sufficiently to support the production of large water volumes in conjunction with down-dip oil recovery, the Unit Operator performed an extensive investigation to arrive at the most feasible long-range plan for artificially lifting Holt-Bryant wells. As a result, it was determined that gas lifting could best accommodate about 75% of the field — essentially the western three-fourths area; therefore, a high pressure gas lift system, supplied with dehydrated gas from the Delhi Natural Gasoline Plant, was installed and activated in latter 1958.

Gas distribution line. The main distribution line is approximately 9 miles in length and composed of 6, 4 and 3-in. diam pipe which is externally coated, wrapped and buried. The sys-

FIG. 1. **Fieldwide high pressure gas lift system** in the Delhi Unit of Richland, Franklin and Madison Parishes of Northeast Louisiana where Sun Oil Company is the operator. Solid line is the main gas distribution system; dashed lines are the individual well lateral lines.



"I don't believe in fluid-loss additives!"

Maybe *you* don't, Oliver, but have you heard about all the service companies that *do*? Their fracture extension calculations—more times than not—predict the need for an effective fluid-loss additive. And that's where remarkable new ADOMITE-MARK II comes in.

In over 25,000 fracturing treatments, ADOMITE fluid-loss additives have produced a consistent record of larger fractures and faster payouts . . . with greatest long-run economy!

So, don't be fooled or tempted by the lower initial cost of less satisfactory techniques.

For larger fractures per volume of fracturing fluid . . . or same-size fractures with less fluid volume . . . insist on ADOMITE!

Remember: among operators who use a fluid-loss additive, eighty per cent choose ADOMITE!

Changed your mind, Oliver?

For more information, contact your service company or the nearest ADOMITE man:

R. T. Means, P.O. Box 431, Midland, Texas, MU 4-7411
T. M. Brown, Pampa, Texas, Phone MO 5-2992
J. M. Foster, Wichita Falls, Texas, Phone 723-8181
J. D. Hawsey, Midland, Texas, MU 4-7411
R. W. Hughes, Oklahoma City, Okla., Phone CE 2-1371
H. L. Thomason, Casper, Wyoming, Phone 3-3721

ADOMITE®

... fluid-loss additives

"25,000 larger fractures can't be wrong!"

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

How SPANG Pipe measures up to perfection

This microscopic inspection of SPANG Extreme Line threads is one of National Supply's many tests to make sure pipe products are as close to perfection as man can make them. This 30″ comparator and measuring machine projects an image of the actual threads, enlarged over 30 times, onto a translucent template screen. Marked on the screen are the contours of perfect threads, with which the actual threads are compared. The machine is used for checking accuracy of inspection and production gauges, as well as finished products. This inspection technique is typical of National Supply's stringent quality control of all tubular products.

Read about SPANG Extreme Line casing on next pages

Why SPANG Extreme Line casing out-performs other casing in deep, high-pressure wells

1. HIGH JOINT STRENGTH

Basic design of the modified Acme thread with a small included flank angle permits joints to resist heavy axial loading as a unit. Broad, flat thread engagement eliminates pull-out failures common to conventional threaded joints.

2. POSITIVE RESISTANCE TO LEAKAGE

Unique metal-to-metal seal makes SPANG Extreme Line casing 100% leak resistant. Precision machined seals on box and pin ends bear up under the heaviest loads in tension and compression.

3. MINIMUM OUTSIDE DIAMETER

Integral joint eliminates couplings. Unique design provides greater strength with considerable reduction in diameter. Extreme Line casing affords greater clearances than T&C when run inside a given diameter of outer string or open hole.

4. MAXIMUM SPEED IN RUNNING

Cross threading is practically impossible. Any initial misalignment is automatically corrected by the broad, flat-crested threads which guide the pin quickly into positive engagement with the box.

High running speeds with SPANG Extreme Line casing were obtained at this Louisiana well.

Steel

Steel's Symbol of strength, long life, and economy

5. STREAMLINED EXTERIOR CONTOUR

There are no shoulders to hang up, catch on obstructions, or scrape the filter cake from the wall of the hole. Streamlined contour minimizes friction, speeds recovery when casing is pulled.

6. HIGH RESISTANCE TO DAMAGE

The strong, broad Acme-type threads on SPANG Extreme Line casing absorb and distribute the impact of accidental blows, which could seriously damage the "V" threads of T&C casing.

7. ABILITY TO BE RE-RUN

SPANG Extreme Line casing can be re-run many times without galling. The square, sturdy thread design affords higher recovery than API casing, without rethreading.

8. ONE-HALF LESS THREADED CONNECTIONS

Design of Extreme Line casing reduces the number of threaded connections to one-half those required with T&C casing because the coupling element is an integral part of the casing.

Next time you buy casing, investigate the many advantages of this superior quality casing. It is readily available in Grades J-55, N-80 and P-110. Call your National Supply representative for complete information.

Extreme Line casing is just part of National Supply's complete line of oil country tubular products. SPANG Drill Pipe and National Drill Collars were also used in this Louisiana well. National Supply is the only company manufacturing both drill pipe and tool joints.

Gathering line service is one of the many oil field applications for dependable SPANG CW Steel Pipe. In addition to gas, oil and water lines, you can use it for roof rails, step rails and many other structural purposes.

SPANG CW Steel Pipe is easy to cut, bend, thread and weld

When you specify SPANG CW Steel Pipe for oil, gas or water lines, you can be sure of top quality pipe . . . without premium prices.

SPANG quality control in every step of production and shipping is the answer. Every length of pipe is hydrostatically tested and inspected for strength and uniformity. Every length is made of carefully selected steel that meets stringent standards.

All sizes of SPANG CW Steel Pipe, plain end or threaded and coupled, are available now. Call your nearest National Supply representative for prompt, dependable delivery. You'll be glad you did.

THE NATIONAL SUPPLY COMPANY

Two Gateway Center, Pittsburgh 22, Pennsylvania

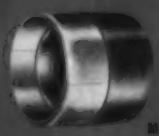
Subsidiary of Armco Steel Corporation

DIVISION OFFICES: Calgary, Columbus, Dallas, Denver, Houston, Torrance, Tulsa

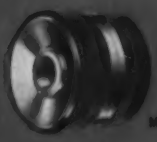
EXPORT: 600 Fifth Avenue, New York 20, N.Y., U.S.A.; City Wall House, Chiswell Street, London, E.C. 1

* Mission pump parts work together

MISSION VALVES



MISSION GLAND PACKING



MISSION PISTONS

MISSION LINERS

MISSION PISTON RODS

MISSION LINER PACKING

*SMOOTHLY . . .

From watches to locomotives, mechanical parts work better together when they're designed and built to work together. The same is true for mud pump parts. With the Mission Guarantee you know that individually each part—liners, pistons, rods, valves and seats, packing, and springs—will outperform any others. But, when you put them together, allow them to do their best, the savings you get are even greater. And the other side of savings is your profit.

When you put Mission pump parts to work you know you're using the best, that's guaranteed; but you also are helping yourself the most, cutting your own costs. Start now to stop the waste of shopping around and standardize on Mission all the way.

MISSION MANUFACTURING CO.

MISSION MANUFACTURING CO., P. O. Box 4200, Houston, Texas, cable address "MFGCO" • export office: 30 Rockefeller Plaza, New York • in the United Kingdom: MISSION MANUFACTURING CO., LTD., 1 Hanover Square, London W. 1 England • cable address "MISSOMAN"

66—300

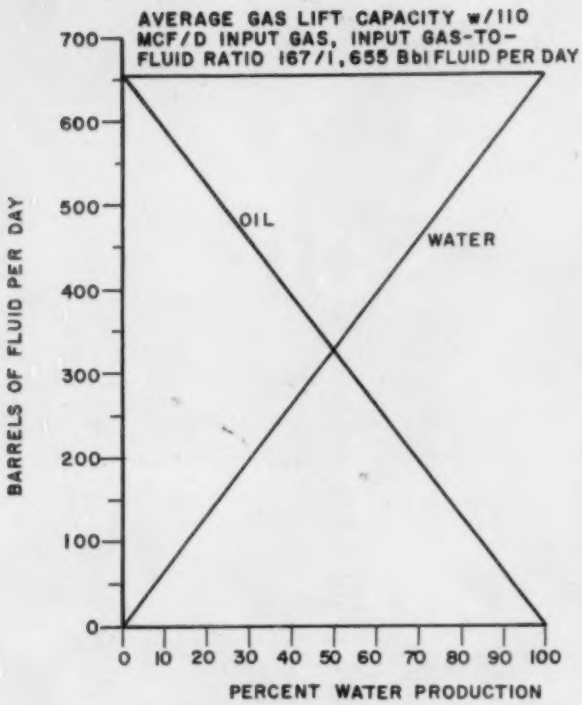


FIG. 2. **Average per well gas lift capacity** versus water production at 110 Mcf input gas per day, input-gas-to-fluid ratio of 167 to 1; and 655 bbl fluid per day. Note that artificial lift is required at about 58% water production.

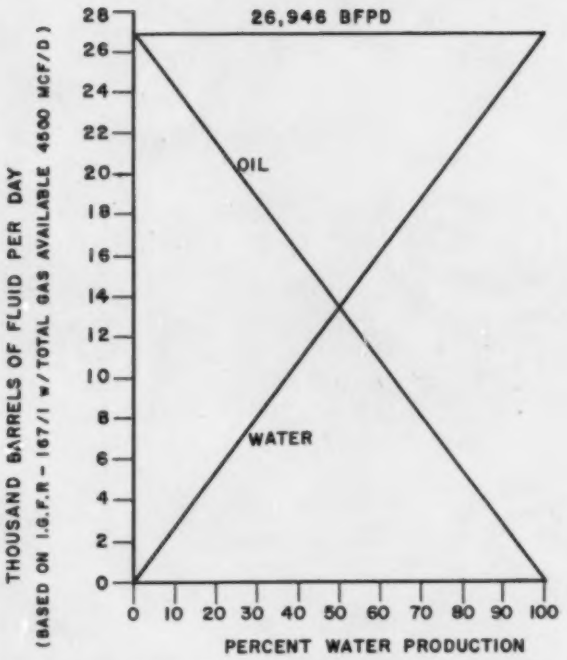


FIG. 3. **Estimated fieldwide gas lift capacity** versus percent water production, based on a total available gas supply of 4500 Mcf per day and input gas-to-fluid ratio of 167 cu ft per bbl of produced fluid.

tem is designed for a maximum continuous volume delivery of 6500 Mcf/d with 550-575 psig pressure. It is anticipated that at least 130 wells will be serviced throughout the life of the primary reservoir; nevertheless, no more than 35-40 wells should require simultaneous lifting.

Lifting operations. Although 22 wells were equipped for gas lifting at this writing only 14 are active, since 8 resumed natural flow shortly after gas lift commenced. The 14 active wells are recovering 1975 BOPD and 8745 BWPD (82%) with 1448.2 Mcf/d input gas, an average input gas-to-fluid ratio of 135 cu ft per bbl fluid and input gas-to-oil ratio of 733 cu ft per bbl oil. Average direct lifting costs approach only 4.6¢/bbl oil and daily per well production, utilizing 103.4 Mcf/d input gas, amounts to 141 BOPD with 625 BWPD, a fluid total of 766 BFPD. To provide for gas lifting currently entails an average installation cost of approximately $2300 per well and payout of the complete system, including the $100,000 distribution line, will be accomplished within a total period of less than two years. With respect to both performance and economics, present-day evidence substantiates that the fieldwide gas lift network of the Delhi Unit is achieving its basic functions: elevated rates with reduced lifting expense.

How System Was Planned

Inasmuch as the major productive zones of the Delhi Unit seemed well suited for gas lift application, and considering that adequate supply could be provided by the Delhi Natural Gasoline Plant, a fieldwide study was initiated to develop a fundamental program.

Incorporating prior history, it was established that artificial lifting normally becomes necessary as water production approaches an average 58% within the Holt-Bryant Reservoir, although the magnitude of this value fluctuates somewhat from region to region in response to variations of formation characteristics. By relating this information and known vertical encroachment rate of the oil-water contact to structural locale of the current perforated interval, a complete per-well analysis was performed which indicated that, besides the 38 wells then on artificial lift, at least 42 additional wells would necessitate artificial lifting by June 1, 1961, a period of about three years from the original time of review.

It was also discovered that an aggregate of only 70 wells would demand auxiliary artificial lifting facilities

ABOUT THE AUTHOR

Luther F. Ellison was recently transferred to Sun Oil Company's Southwest Division headquarters in Dallas as assistant to the regional superintendent. A 1950 graduate of Texas A & M College with a bachelor of science degree in petroleum engineering and a BS degree in geological engineering, he joined Sun in East Texas shortly after graduation. For the following four years, he worked in various engineering capacities throughout the Gulf Coast and South Texas areas. He served as Delhi Unit engineer from 1954 until his transfer to Dallas.

NEW!
POLY PLUG
FOR PREVENTION AND CONTROL OF
LOST CIRCULATION
AN ENGINEERED BLEND OF GRANULAR PLASTIC AND NUTSHELL WITH FIBROUS MATERIAL
EASILY SUSPENDED NON-ABRASIVE
FOR CONTROL OF LOST CIRCULATION
*POLY PLUG
*TRADEMARK
ANOTHER MAJOR DEVELOPMENT IN LOST CIRCULATION MATERIAL!
(PATENT APPLICATION IN PROCESS)
• Using laboratory and field data, Cherokee has, by an engineered blending process, developed Poly-Plug for the prevention and control of lost circulation.
• Cherokee's Poly-Plug is an engineered homogeneous mixture of components chosen as having been individually accepted to be the most effective materials used in certain cases of lost circulation.
• The combination of materials which make up Poly-Plug are: 1. Ground and graded granular plastic. 2. Ground and graded hard nutshell. 3. High strength inert fibre.
• Cherokee's Poly-Plug is offered at a very nominal cost.
• Cherokee's Poly-Plug is available now in the coarse (maximum particle size ¼") grade only.
• For further information, contact your local mud company or the Cherokee Laboratories' representative nearest you.
CHEROKEE LABORATORIES, Inc.
P. O. Box 587 • Tulsa, Oklahoma • LUther 4-7285
BRANCHES CODY • CASPER • GRAND JUNCTION • OKLAHOMA CITY
ODESSA • MIDLAND • McALLEN • CORPUS CHRISTI • HOUSTON • DeQUINCY • LAFAYETTE • NEW ORLEANS

You save drilling dollars with

THE

MUD PROBLEM: Maintain a stable bay-water mud to drill through hydratable shales and formations containing high pressure gas and salt water.

WELL DATA

Location: Timbalier Bay Field, Lafourche Parish, Louisiana
Total Depth: 15,376′

MUD ADDITIVE PROGRAM

0′ to total depth	Q-BROXIN*, BAROID**, bay water, caustic soda, gypsum.
12,876′	Mud density increased to 12.3 ppg; Q-BROXIN treatment increased; Baroid Mud Centrifuge installed.
13,276′	FINE MICATEX**, and other lost-circulation materials added, maintained to total depth.
14,302′	Diesel oil added, maintained at 6% to 10% by volume to total depth.
14,510′	TRIMULSO** (0.5 lb/bbl) and E P MUD-LUBE†, (4.0 lb/bbl) added, maintained to total depth.

TYPICAL MUD PROPERTIES

Depth, feet	12,950	13,464	14,064	14,510	15,003	15,376
Weight, ppg	12.1	12.5	13.3	14.3	15.6	16.6
Ave. sp gr, solids	2.8	3.0	3.0	3.2	3.8	3.7
Viscosity, sec. API	55	48	54	66	58	65
Stormer Gel, 10 min	25	25	20	10	7	15
Filtrate, ml, API	5.5	4.9	3.9	1.6	1.8	1.2
pH	10.9	10.4	11.1	10.4	10.2	10.6
Chloride, ppm (1000's)	19	23	21	23	22	23
Oil, %	0	0	0	6	9	7

CASING PROGRAM

Size Inches O.D.	*Depth Set Feet*
13⅜	6,464
9⅝	14,871

DISCUSSION: Major difficulties were anticipated below 14,000′ because of gas-bearing hydratable shales. Side wall coring, electric and induction logging and similar operations required an exceptional mud program. Salty bay water was used for making-up the liquid phase of the mud.

SOLUTION: Q-BROXIN mud was chosen as the basic mud additive from surface to total depth. The treated mud had a high degree of tolerance for solids, an inhibitive effect on hydratable shales and was not greatly affected by contaminants. BAROID was added to maintain weight, and FINE MICATEX was used to maintain good hole condition below 14,500′.

Total mud cost was about one-half the cost of previous wells of similar depths. 14,871′ of 9⅝″ casing was successfully set and cemented, the deepest of this size in this field. Side wall cores and good logs were obtained without difficulty.

**Registered Trademark, Baroid Division National Lead Company
†Trademark, Baroid Division National Lead Company
*Registered Trademark of Puget Sound Pulp and Timber Company

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

a Baroid Mud Program

MUD PROBLEM

... and its solution

Total mud costs were cut in half and tight-hole problems were solved in this typical case history of a Baroid mud program. Through experienced engineering skill, a combination of Baroid mud additives were matched against a combination of down-hole conditions with successful results.

Gas pressure, salt contamination and tight-hole conditions were expected at depths below 14,000'. Side wall coring and electrical logging were desired. Using a bay-water — Q-BROXIN mud, frequent pilot testing, and special-purpose Baroid additives permitted successful drilling of the well and setting 9⅝" casing to a record depth in this field.

This demonstration is repeated daily in every major oil area. Baroid's improved concept of mud marketing is winning approval. By integrating material production, engineering research and distribution into a single chain, administered with utmost integrity, Baroid solves your problems and *saves your drilling dollars.*

RESISTS ANHYDRITE CONTAMINATION
OVERCOMES EFFECTS OF SALT WATER
KEEPS MUD STABLE AT HIGH TEMPERATURE
KEEPS MUD DEFLOCCULATED

BAROID

BAROID DIVISION NATIONAL LEAD COMPANY

MAIN OFFICE: P. O. BOX 1675, HOUSTON 1, TEXAS

6008

Photo 1. Block valves on main distribution line are about one mile apart and mounted horizontally above ground for ease of operation. Gage on top of valve at right permits evaluation of line performance. Valve is to blow-down the line if necessary.

within a 10-year period subsequent to the survey, which inferred that 60% of the near-future artificial lifting needs throughout the major productive zone of the Delhi Unit would develop by mid-year of 1961.

These findings emphasized that the consideration of a fieldwide gas lift system could not be delayed. Furthermore, distribution of the 42 wells denoted that the entire main line would be required within the 3-year period, and thereby eliminated the prospect of piece-meal installation.

Well testing program. With an explicitly defined immediate and near-future need for large-scale artificial lifting facilities, it was then necessary to determine the degree of gas lifting efficiency which might be expected throughout the field in order to earmark probable per-well supply volume requirements. Several representative wells, all normally shut-in with the allowables transferred, were equipped for gas lifting and tested periodically with a portable compressor to procure the following essential information:

Daily Average Per Well Test Data — Gas Lifting

Average Oil Production	91 BOPD
Average Water Production	564 BWPD
Average Fluid Production	655 BFPD
Average Percent Water	86%
Average Input Gas	110 Mcf/d
Average Formation Gas	51 Mcf/d
Average Input Gas-Fluid Ratio	167 cu ft/BF
Average Input Gas-Oil Ratio	1203 cu ft/BO
Average Formation Ratio	562 cu ft/BO
Input Supply Pressure	450-500 psig
Lifting Depth	1000-1750 ft

Basis for distribution system. Positioning of the main distribution line centered about the anticipated maximum or peak load demand. To identify this condition involved a comprehensive per-well review of the field which utilized encroachment rates, structural elevation of separate sections, critical ranges of water production, etc., to determine when various periods of artificial lifting should occur during the expected life of each well. Combination of per-well data indicated that the maximum artificial lifting load of the Holt-Bryant Reservoir should develop near 1970, when 35 wells will require simultaneous lifting. On this basis, the primary distribution line was designed to sustain 35 wells for peak demand and located to best accommodate this obligation, as depicted by Fig. 1. A heavily inhabited town area limited the eastern extent of the system.

DESIGN AND COSTS

Insofar as average test data reflected that 655 BFPD could be gas lifted by 110 Mcf/d input supply with an input gas-to-fluid ratio of 167 cu ft/BF, it was decided that this condition would

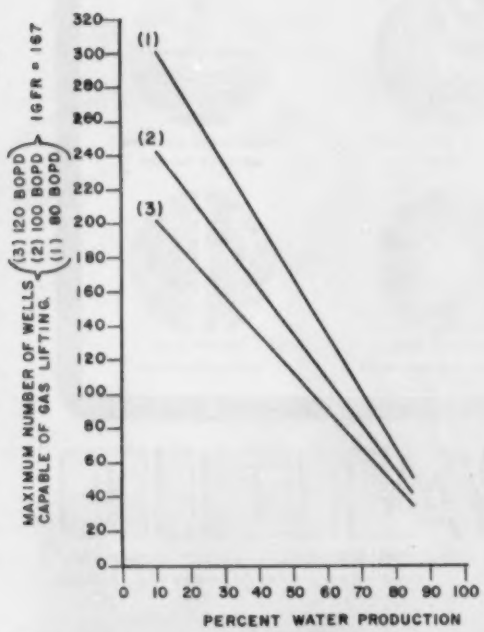


FIG. 4. **Fieldwide gas lift capacity** and water production assuming total gas available is 4500 Mcf per day and an input gas-to-fluid ratio of 167 cu ft per bbl. Note: artificial lift required at about 58% produced water.

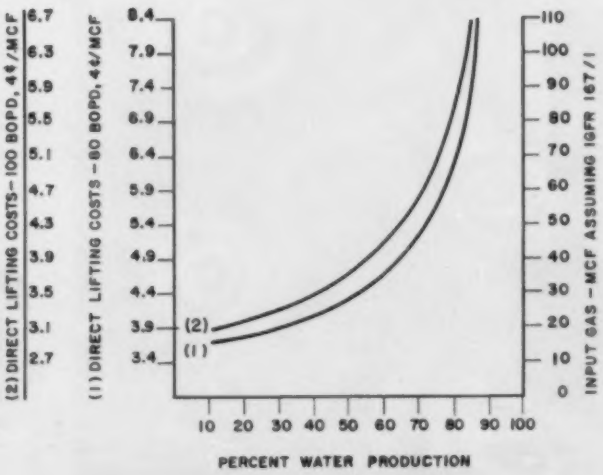
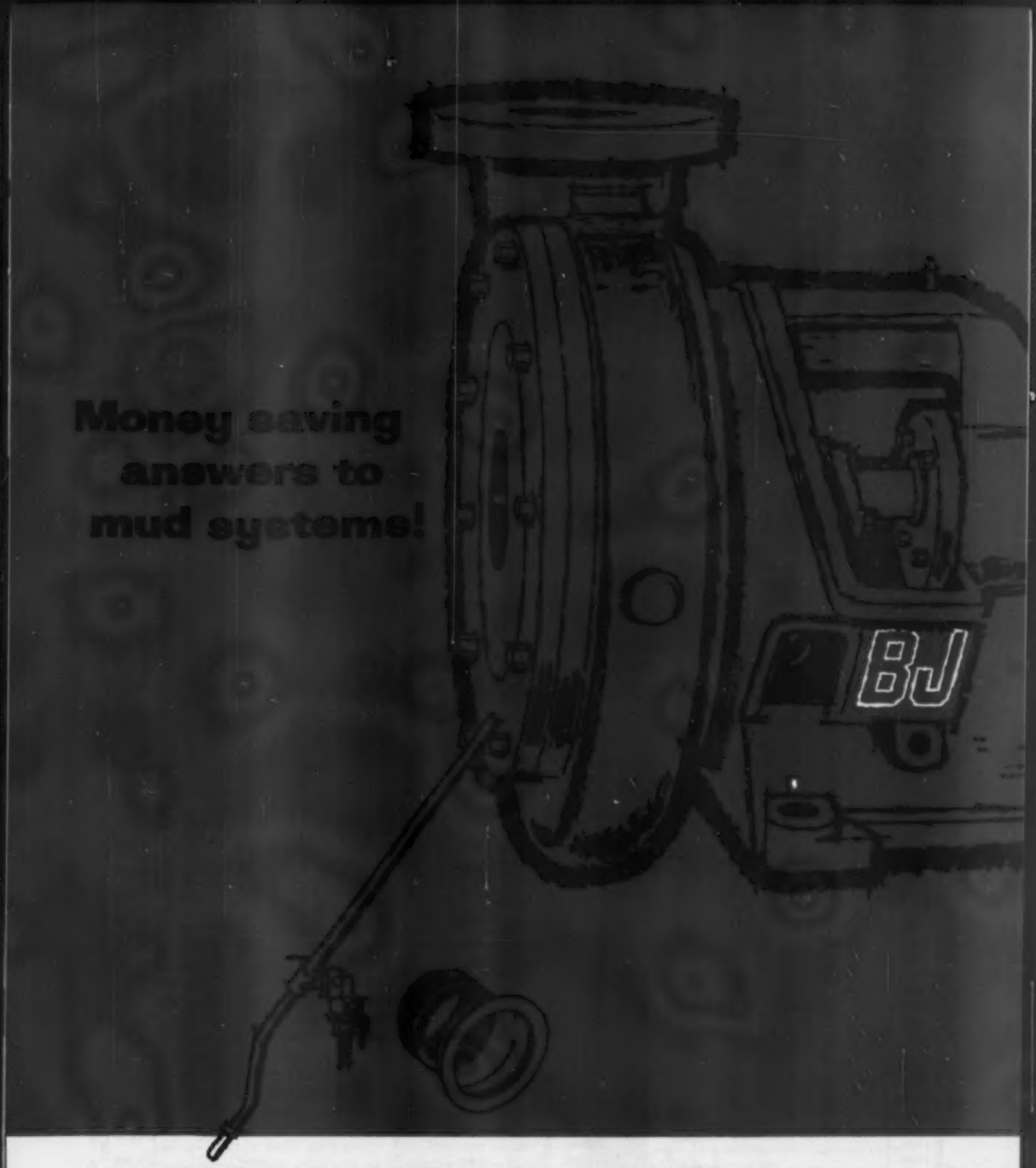


FIG. 5. **Direct gas lifting costs** for 80 and 100 bbl of oil per day for various percent of water production. Assumed costs: (1) for labor, $698.17 per well per year; (2) pulling costs, $150 per year; and (3) input gas costs at 4 cents per Mcf at an input gas-to-fluid ratio of 167 cu ft per bbl.



Pumps, Tank Connectors, Mud Guns. Save money, save time, increase operating efficiency with mud system products engineered by Byron Jackson. Cut mud processing costs to the bone by using BJ Centrifugal Pumps to replace or supplement expensive reciprocating pumps. Total savings may run as high as 90%! For mud tank and slush pump hook-ups, you'll save with BJ Flex-Line and Flex-O Connectors. Flexible, versatile and easily installed, they provide a positive, leakproof seal... compensate for angular misalignments of up to 10°. And for more efficient mud mixing BJ offers ball-swivel and bottom type mud guns that give long, trouble-free service in all mud programs.

Send for bulletin (No. BJT-60-148), which gives details on reducing mud processing costs with BJ Centrifugal Pumps.

Byron Jackson Tools, Inc.
A SUBSIDIARY OF BORG-WARNER CORPORATION

P.O. Box 2017-A, Terminal Annex, Los Angeles 54 • P.O. Box 2198, Houston 1 • Export Address: 580 5th Ave., Suite 510, New York 36

BJ

support reasonably high oil rates and appeared appropriate for design purposes. Resolving fluid recovery to water production, Fig. 2 graphically illustrates producing potential with respect to variable percentages of water. It is obvious that additional lift capacity could be derived with increased input supply gas. Since peak load keynoted 35 wells as probably the maximum number to necessitate simultaneous gas lifting from the system, an assumed per well consumption of 110 Mcf/d then established that the ultimate gas supply need should approach 3850 Mcf/d ($35 \times 110 = 3850$).

Daily gas volumes required. In addition to the supply obligation for Holt-Bryant gas lifting, it was also necessary to plan for 2000 Mcf/d in order to perpetuate an already active gas injection program within a smaller reservoir situated near the western terminus of the line. Therefore, a theoretical composite design volume of 5850 Mcf/d evolved ($3850 + 2000 = 5850$). However, the Delhi Natural Gasoline Plant could assure delivery of 6500 Mcf/d without major revisions and this value, 6500 Mcf/d, was accepted as the peak volume load. On this basis, 4500 Mcf/d was specified for gas lifting and the remaining 2000 Mcf/d was designated for injection purposes.

Gas lift capacities. Assuming an available input supply of 4500 Mcf/d in conjunction with the average anticipated input gas-to-fluid ratio of 167 cu ft/BF, Fig. 3 and 4 represent the expected composite lift capability of the integral system under variable

Photo 2. Main line injection block valves at junction of system where main line from gasoline plant joins east and west wings of distribution line.

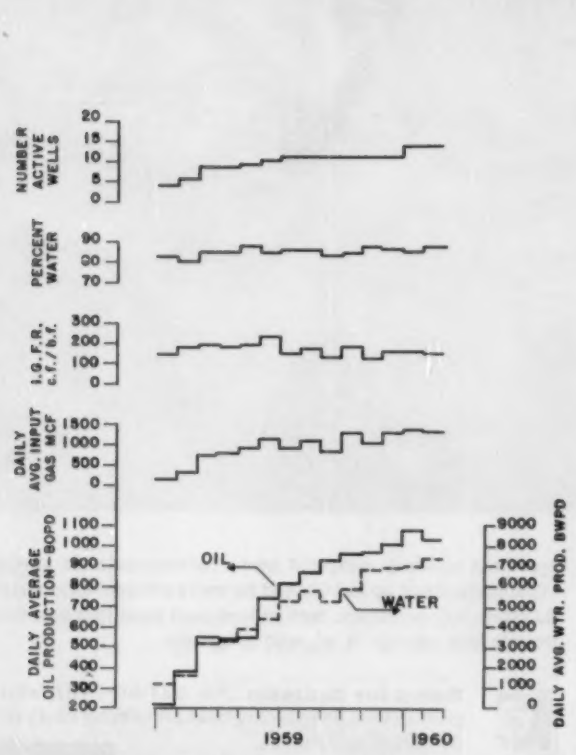


FIG. 6. **Average fieldwide gas lift performance** as of March 1, 1960, for the Holt-Bryant Sand of the Delhi Unit.

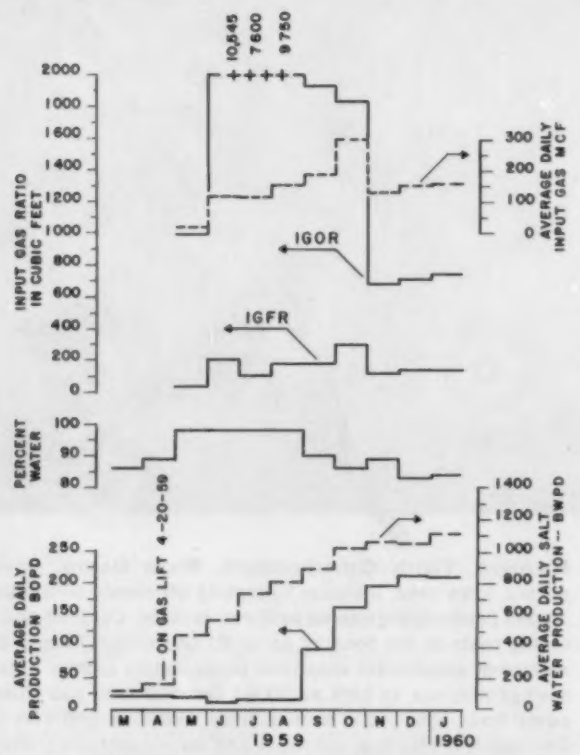
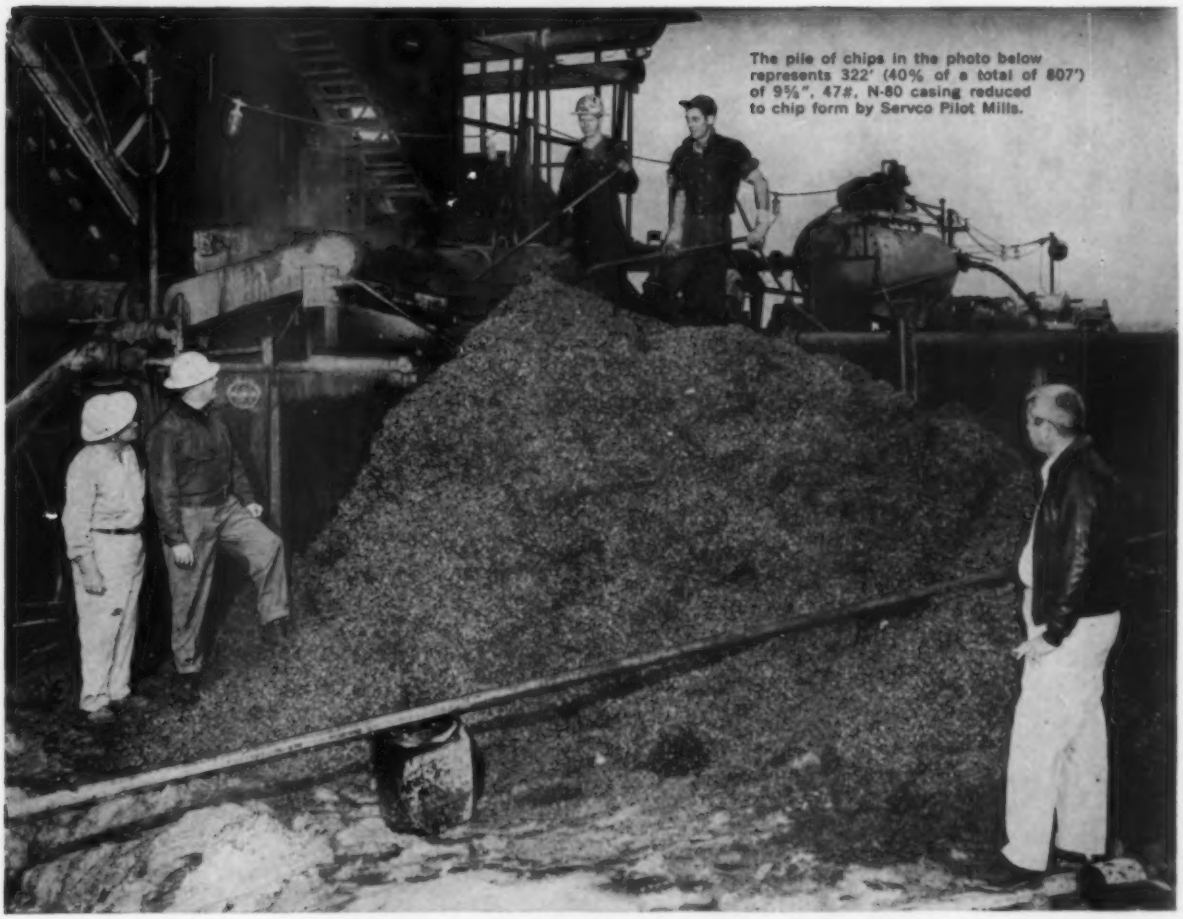


FIG. 7. **Gas lift performance** of one well, DU 179-2, demonstrates how producing characteristics have been improved.



The pile of chips in the photo below represents 322' (40% of a total of 807') of 9⅝", 47#, N-80 casing reduced to chip form by Servco Pilot Mills.

Servco Pilot Mills mill 807' of 9⅝", 47#, N-80 casing at an average rate of 4.6' per hour!

In running a long string of 9⅝", 47#, N-80 X-line casing, the pipe became stuck at 5862'. Free pipe was recovered to 4139'. Approximately one month's fishing time was then spent in cutting and pulling 700' of casing. At this point SERVCO was called on the job. *In the next 12 days eleven SERVCO Pilot Mills milled 807' of casing (37,929# of steel), including 4 centralizers and 18 couplings, at an average rate of 4.6' per hour (216# of steel per hour).*

The Pilot Mills used on this job were dressed with SERVCOLOY "S," SERVCO's unique patented steel cutting carbide material. Their performance is typical of the results SERVCO mills give every day. You can obtain these same results with any of SERVCO's tools—they are revolutionizing down-hole fishing and recompletion work.

Ask your SERVCO representative for information. He has the results from nearly 4000 successful jobs to help you.

SERVCO

...the modern drilling tools

General Offices:
2440 Cerritos Avenue,
Long Beach 6, California
Canada: 6909 104th Street, Edmonton, Alberta
Venezuela: Maracaibo
France: 106 rue Lauriston, Paris 16
Trinidad: San Fernando
Field Offices: Ventura, Bakersfield, Lafayette, Harvey, Casper, Oklahoma City, Houston, Odessa, Williston

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

HERE'S THE BIT THAT WILL CHANGE YOUR MIND!

.....

FASTER PENETRATION
FULL GAGE HOLE--

The new Reed Y bits have changed the concept of how fast a hole should be drilled. These Y bits have been setting impressive records in fast drilling all over the oil country. Advanced design, using special alloy steels combined with precision manufacturing, provides maximum rate of penetration—in a straight, full gage hole.

The ability to hold gage is a built-in feature in every Reed bit you buy. Continuing research, hard hitting engineering, modern metallurgy, and forty-two years experience have developed a bit that will hold gage all the way.

Ask the Reed man who calls on you to give you the full story. He'll convince you that the bit to buy—if you want faster penetration and a full gage hole—is the modern Reed Y bit.

REED ROLLER BIT COMPANY *Houston 1, Texas*

EXPORT OFFICE: TIME AND LIFE BLDG., SUITE 3744 ROCKEFELLER CENTER, NEW YORK 20, N.Y. * GULF COAST, MID-CONTINENT AND ROCKY MOUNTAIN DISTRIBUTOR FOR MARTIN-DECKER PRODUCTS.

REED

REED'S ROLLIN'

RE TS

...and this is just the beginning!

lower your cost of possession

2 Nickel Alloy Steels provide

A simple plan to save money by steel standardization

How many types of steel do you normally use?

Chances are you should examine your needs for alloy steel to see how many can be satisfied with just two types, 4340 through-hardening and 4620 carburizing.

You are likely to find that most of your engineering requirements can be met with confidence when you *standardize* on these two general-purpose steels.

You simplify inventory and materials-handling. You save money in purchasing and production, too.

• 4340 stands alone among medium-carbon steels in its ability to provide maximum strength, ductility, toughness and resistance to fatigue in parts of medium to heavy section.

• 4620 is a carburizing type that has consistently proved itself the ideal steel for a wide variety of carburized parts. 4620 is easy to carburize and has a minimum tendency toward distortion in heat treatment.

Available From Steel Service Centers

Both 4340 and 4620 are stocked by Steel Service Centers from coast to coast, ready for off-the-shelf delivery in a variety of sizes.

When you have carried your standardization plan as far as you can and you still have specialized needs to fill, the right nickel steels are available to give you extra performance or even lower costs.

For a buyer's guide to Steel Service Centers that stock 4340 and 4620, and other nickel-containing grades, simply write Inco.

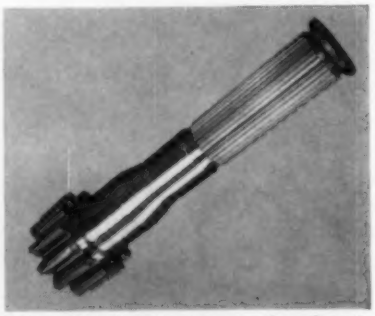
STEEL SERVICE CENTER INSTITUTE

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

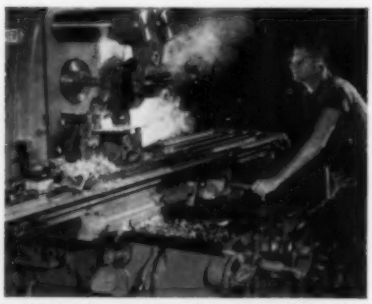
INCO TRADE MARK

Holding the Shippingport nuclear reactor's top head to its shell section is a job performed by 42 studs of AISI 4340. This through-hardening nickel steel provides essential strength and toughness.

Power-packed tractor features unique drive mechanism composed of regular gear transmission, clutch and torque converter with lock-up, utilizes nickel alloy steels in more than 25 components.



Swing shaft for giant power shovel made from 4340 nickel alloy steel for strength and toughness to take shock-loading in stride. This 9"-diameter, 36"-long shaft of 4340 nickel alloy steel transmits tremendous torque to a giant ring gear.



Sustained accuracy is assured in this heavy-duty milling machine by spindle and gear components of AISI 4340 and 4620 nickel alloy steels. They provide needed strength and wear resistance.

functions of oil and water recovery. Fig. 3 denotes an aggregate lifting capacity of almost 27,000 BFPD; whereas, Fig. 4 relates this lifting capacity to number of wells versus varying ranges of water recovery.

An evaluation was also made with respect to probable direct gas lifting costs, and included basic items with variable rates of both oil and water production. Fig. 5 clearly reflects this analysis and emphasizes the basic economics which might be expected with the overall program.

Distribution line. Utilizing 6500 Mcf/d as peak volume for design purposes, the main distribution line, originating from the Delhi Natural Gasoline Plant, was designed to experience a maximum velocity loss of 75 psi at the western extremity, where 475 psig pressure seemed adequate for lifting purposes. Differential velocities at peak load distribution were applied to standard tables and, to minimize expense, the line was tapered in size accordingly. The final composition was calculated as follows:

Length-Ft.	OD-In.
16,500	6
17,300	4
14,300	3
Total: 48,100	

The total cost of installation, including right-of-way procurement and clearance, external coating, wrapping, ditching, valves, connections, etc., approximated $100,000, and the line consists of relatively light-weight welded pipe.

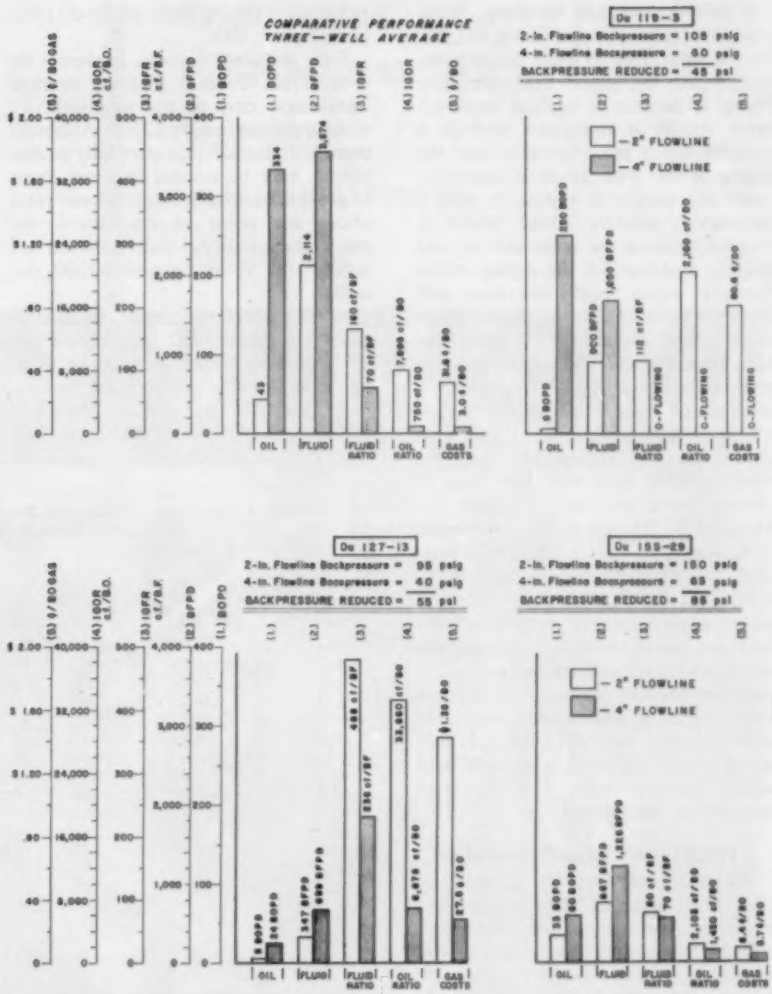


FIG. 8. Effect of flow line back pressure upon performance of gas lift is graphically demonstrated by the above charts showing comparative test data when flow lines from three wells were converted from 2-in. to 4-in.

Photo 3. Typical tap tie-in from main line to 2-in. lateral connected to individual producing wells.

INSTALLING THE SYSTEM

In addition to economic sizing, the primary line was designed for flexibility, simplicity of operation and accessibility. To expedite repair and minimize blow-down losses in the event of leakage, the system is equipped with block valves which are approximately one mile apart and uniformly installed throughout, as reflected by Photo 1. Note that the valve is horizontal and above the ground to permit rapid, ease of operation. All valves are positioned in readily accessible localities to hasten remedial measures. A blow-down valve, situated to the east and directly adjacent to every block valve, is provided with a pressure gage to allow evaluation of the line performance at various points within the system. As a matter of interest, Photo 2 illustrates the installation pattern utilized at the main junction shown by Fig. 1, where southward moving gas from the Plant is directed to both east and west wings of the distribution line. The blow-down (Photo 2) is situated between the two block valves and a tap tie-in, extreme left, currently provides supply to gas lift three wells.

Two-in. laterals. The primary system was originally equipped with 37 vertical tap tie-ins which, without interrupting operation, offer an available supply outlet within each one-quarter section of the serviced area. Furthermore, the average well distance from a supply outlet approaches only 900 ft.

This arrangement minimizes velocity effects and permits the use of 2 in. diam lateral lines, since two wells are usually the maximum number to be fed from the same direction of a tap tie-in. Photo 3 depicts a standard and typical tap tie-in which delivers to a single lateral unit. With smaller sized laterals, inactive sections can be readily moved and utilized elsewhere.

Standard wellhead hook-up. Wellhead installation for gas lifting has also been standardized to minimize expense and simplify the overall field operation. Photo 4 denotes a typical hook-up. Input supply is measured through a portable tester prior to entry into the casing of the well. In most instances, input gas supply is regulated with a removable, positive choke which is situated between the cross and tee and directly upstream of the casing valve. Pressure gages, both upstream and downstream of the casing choke, allow rapid visual evaluation of down-the-hole operation. Wellhead and flowline pressure are also gaged to provide a measure of back pressure conditions, which critically influence lifting efficiency. Recently, several 2-in. flow lines were replaced with 4-in. flow lines to reduce back pressure. Results are analyzed at the end of this discussion.

As stated previously, the Delhi Natural Gasoline Plant provides dehydrated gas for the fieldwide system to insure against internal corrosion, surface and down-the-hole; whereas, the distribution system is coated and wrapped to prevent external corrosion. Electrolytic processes are combated with suitably located insulated connections and cathodic protection beds which service other line systems throughout the Delhi Unit.

FIELDWIDE PERFORMANCE

As of March 1, 1960, 22 wells of the Holt-Bryant Reservoir are equipped for gas lifting. However, only 14 are presently active, since eight resumed natural flow soon after gas lifting commenced. With 14 months of production history available to date, the overall performance has been highly satisfactory.

Table 1 and Fig. 6 tabulate and graphically summarize composite performance of the system included within the 14 months period of study: January, 1959 through February, 1960. Utilizing 405,304 Mcf gas, the active wells lifted 321,977 bbl oil and 2,060,900 bbl water, a total of 2,382,897 bbl fluid (86% water). This represents an average input gas-to-fluid ratio of 170 cu ft/BF and input gas-to-oil ratio of 1259 cu ft/BO.

Insofar as the basic line design incorporated an average input gas-to-fluid ratio of 167 cu ft/BF, the general degree of efficiency is in close agreement with the expected response. In fact, the most recent test information which best reflects present-day performance has been itemized by Table 2 and indicates an even higher degree of operational efficiency from the integral system as stressed by the average input gas-to-fluid ratio of only 135 cu ft/BF with input gas-to-oil ratio of 733 cu ft/BO.

Low installation costs. It should be noted from Table 1 that the average installation cost of the aggregate 22 wells approaches only $2300. Although there is indication that internally coated tubing may be needed in most cases to prevent accelerated corrosional rates above the point of continuous gas entry, the additional outlay should not inflate this value beyond $3000 per well.

With respect to direct operational costs associated with the current gas lift program, Table 2 reveals an average cost of 4.6¢ per bbl oil in conjunction with the average per well production of 141 BOPD with 625 BWPD, 766 BFPD (82%), gas lifted with 103.4 Mcf/d input supply. Considering both performance and economics, the fieldwide gas lift system of the Delhi Unit appears to be accomplishing its basic functions: elevated rates with reduced lifting expense.

Per Well Performance

The lifting depth and number of gas lift valves varies from well to well, in accordance with individual producing characteristics. As a whole, continuous flow wells seldom require more than two valves and a maximum lifting depth of about 1200-1300 ft; whereas, intermittent operation for less permeable wells usually involves four to five valves, sometimes lifting from 2500-2700 ft. In a few instances, where well conditions are near-ideal and ab-

TABLE 1. Summary of Gas Lift Performance, Holt-Bryant Sand, Delhi Unit, January, 1959, through February, 1960, Delhi Area.

DU Well No.	Months on G. L.	Period Production Data BO	BW	BF	%Wtr.	Input Gas —Mcf—	Average Input Gas Ratios—Cu ft/Bbl IGFR	IGOR	Initial Installation Costs —$—
58-9	14	40,372	33,812	74,184	46	5,544	75	1,373	$ 2,201
80-1	14	29,726	255,922	285,648	90	70,966	248	2,387	2,941
88-1	13	15,382	108,146	123,528	88	45,937	372	2,986	2,849
100-1	12	14,404	157,648	172,052	92	58,114	338	4,035	3,407
119-3	12	33,750	223,800	257,550	87	3,276	13	97	3,138
123-18	2	6,689	41,875	48,564	86	7,782	160	1,163	1,260
127-13	14	20,296	278,878	299,174	93	64,606	216	3,183	2,167
140-26	8	25,431	66,360	91,791	72	14,851	162	584	3,188
155-29	13	39,072	191,191	230,263	83	12,188	53	312	2,299
179-2	10	32,493	278,448	310,941	90	40,618	131	1,250	1,942
205-1	14	6,975	157,435	164,410	96	53,142	323	7,619	1,951
211-1	2	6,854	15,512	22,366	69	7,462	334	1,089	2,018
212-1	9	21,551	139,774	161,325	87	16,579	103	769	2,428
227-2	9	28,982	112,099	141,081	79	4,239	30	146	1,946
TOTALS: (14 Wells)		321,977	2,060,900	2,382,897	86	405,304	—	—	$33,735*
						PERIOD AVERAGE:	170	1,259	
						AVERAGE INSTALLATION COSTS (14 Active Wells):			$ 2,410*

*Note:
(1) Total Installation Costs (22 Wells): $49,958.
(Investment = $37,711, Expense — $12,247)
(2) Avg. Installation Cost (22 Wells): $2,271

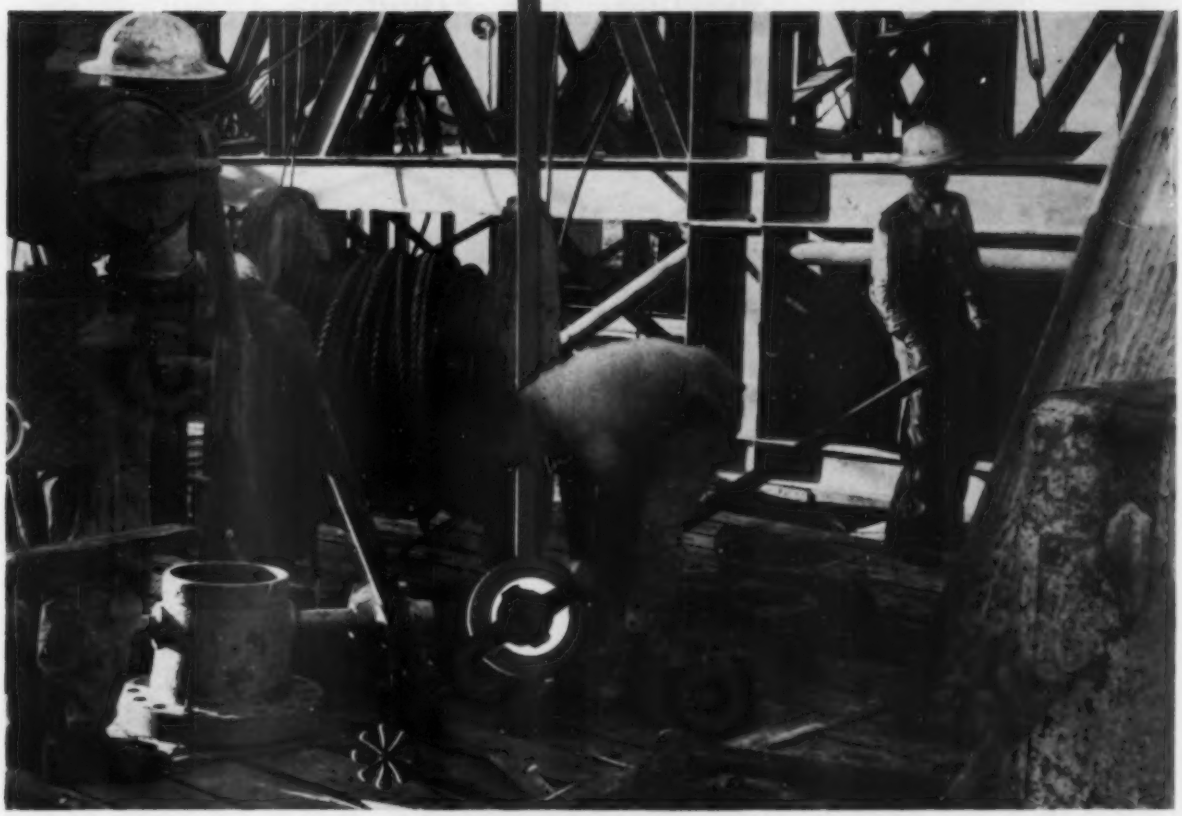
TABLE 2. Per Well Test Data, Active Gas Lift Wells, Holt-Bryant Sand, Delhi Unit, 2-1-60.

DU Well No.	Daily production data BO	BW	BF	% Wtr.	Wellhead pressures TP	CP	Daily input gas Mcf	Input gas ratios-cu ft IGFR	IGOR	Form. GOR	*Method of operation	Direct lifting† costs $ per day	¢ per BO
58-9	450	420	870	48	100	540	40.9	47	91	319	C	$ 3.96	0.9¢
80-1	66	749	815	92	90	475	232.2	285	3520	444	C	11.61	17.6
88-1	29	288	317	91	90	425	56.1	177	1935	2946	I	4.56	15.7
100-1	31	488	519	94	50	450	127.0	245	4099	1741	I	7.40	23.9
119-3	109	1144	1,253	91	130	450	109.1	87	1000	190	C	6.68	6.1
123-18	264	800	1,064	75	125	550	99.0	93	375	251	C	6.28	2.4
127-13	44	480	524	92	100	540	68.2	130	1552	479	C	5.05	11.5
140-26	258	528	786	67	125	500	44.8	57	174	385	C	4.11	1.6
155-29	152	684	836	82	95	550	51.8	62	341	86	C	4.39	2.9
179-2	210	1110	1,320	84	75	500	104.2	79	497	185	C	6.49	3.1
205-1	28	500	528	95	50	510	133.1	252	4706	2379	I	7.64	27.2
211-1	157	354	511	69	125	525	112.0	219	714	340	C	6.80	4.3
212-1	62	600	662	91	60	510	172.7	261	2785	1652	C	9.23	14.9
227-2	115	600	715	84	100	500	97.1	136	845	536	C	6.20	5.4
Totals:	1975	8745	10,720	82	—	—	1448.2	—	—	—	—	$90.40	4.6¢
Per well average:	141	625	766	82	—	—	103.4	135	733	—	—	$ 6.46	4.6¢

*Note: C — Constant Flow; I — Intermittent Flow
†Direct Lifting Costs Include:
(1) Labor — $698.17/well/yr.; (2) Pulling — $150.00/well/yr.;
(3) Supply Gas — 4¢/Mcf Compression Charge.

WECO®

the best connections for all oil country piping



WECO UNIONS

On the drilling rig . . . in production installations . . . in service company operations, WECO Unions give you maximum service, economy, efficiency . . . mean faster, simpler, more secure piping make-up. Available in types, sizes and pressure ratings for every oil field service, you can standardize with WECO Unions and always have the right union in the right place at the right time. Talk to your WECO representative about it, now . . . *and ask him about Chiksan Swivel Joints, too.

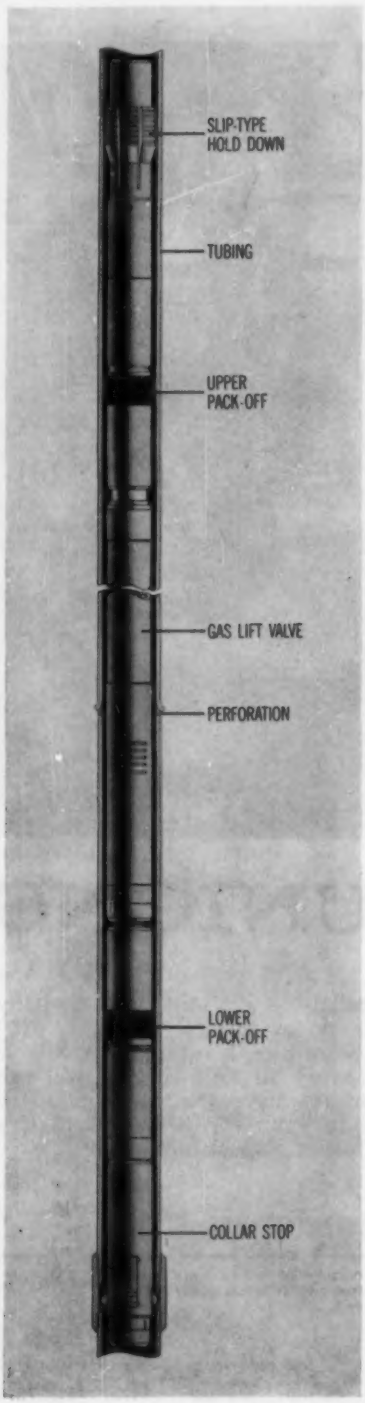
WECO® **WELL EQUIPMENT MFG. CORP.**
HOUSTON, TEXAS
Division of CHIKSAN COMPANY a subsidiary of FOOD MACHINERY AND CHEMICAL CORPORATION

U-7-60

fmc®

OTIS PRODUCTION NEWS

Volume II, Number 3 **Otis Engineering Corporation • Dallas** *Production Equipment and Services*

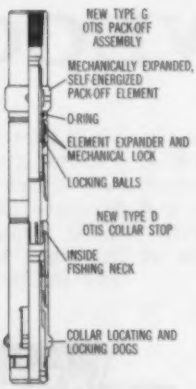


Cost-Conscious Producing Companies Endorse Otis All Wire Line Technique Of Converting Wells to Gas Lift

CORPUS CHRISTI—Eliminate the cost of a pulling unit to round-trip tubing when converting a well to gas lift and you can save an impressive amount of money per well. That's what several of the major producing companies in this area discovered when they started using the new Otis "All-Wire-Line" Gas Lift Conversion Technique.

A spokesman for one of these majors recently stated that his company is most enthusiastic about the technique — especially for water locations — because "(1) it's faster, (2) it's less expensive, (3) it's every bit as efficient as other types of installations they have made, and (4) it eliminates the risk of damage to the producing formation from contamination by mud and/or water in the annulus." Another company reported a savings of $60,000 in converting three, readily accessible, land locations.

As an example of how the technique can reduce the cost of a conversion, take a look at the following case history: A 6800-foot well located in approximately three feet of water in the Copano Bay Field ceased to flow naturally and was scheduled to be put on gas lift. In making plans to have the work done, it was discovered the approach canal had filled with silt and sand, which meant an expensive dredging operation would be necessary before a barge-mounted workover unit could be moved onto location; cost of a workover unit would be $1400 per day, and the annulus was loaded with old drilling fluid. Estimated conversion costs were mounting fast. A conference with the Otis Gas Lift Specialist in the area convinced the operator he should try a Type CG Otis Pack-Off Gas Lift Valve installation.


NEW TYPE G OTIS PACK-OFF ASSEMBLY
MECHANICALLY EXPANDED, SELF-ENERGIZED PACK-OFF ELEMENT
O-RING
ELEMENT EXPANDER AND MECHANICAL LOCK
LOCKING BALLS
NEW TYPE D OTIS COLLAR STOP
INSIDE FISHING NECK
COLLAR LOCATING AND LOCKING DOGS

Straight through, full opening bore of pack-offs, collar stop, and gas lift valve permits maximum production with minimum turbulence.

©1960 O.E.C.

After setting a circulating plug in the tubing at the spot indicated for the lowermost valve, perforating and circulating mud from the annulus, it took the trained Otis Wire Line Specialist only 15½ hours of wire line time to perforate and install five concentric Type C Gas Lift Valves between Type G Otis Pack-Off Assemblies and have the well ready to be put back on production. Eight months following the conversion, the well was still making its allowable in an economical and efficient manner. And to attest to the reliability of the new Type G Otis Pack-Off Assemblies, the well was being produced from the lower-most valve.

Otis Gas Lift and Completion Specialists are interested in helping you find a way to complete and produce your wells in the most efficient manner. The experience these men have accrued throughout the years is yours to draw from when faced with any down well completion or production flow control problem. Use the knowledge these men have to offer and you will find you'll be spending your production dollars more efficiently. For more information on the Type CG Otis Pack-Off Gas Lift Valve, call the Otis office nearest you or write Otis, Dept. 3-W, Box 35206, Dallas 35, Texas. You'll find your Otis specialists ready to help you — anxious to serve you.

OTIS

Engineering OTIS Corporation

General Offices:

6812 Denton Drive • Dallas, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

UP-RATE YOUR RIG

Gardner-Denver BN supercharging mud pump helps you get top-rated pressure and capacity from your main mud pumps—safely and efficiently

REDUCES power end shock.

ELIMINATES impact loading.

EXTENDS fluid parts life.

Gardner-Denver BN pumps are also highly practical for these oil country applications: desanding, degassing, mud mixing and "washdown." Two sizes handle either 500 or 750 gpm. Write for Bulletin BN-1.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario
Gardner-Denver International Division, 233 Broadway, New York 7, N. Y.

Petroleum Offices: Casper, Cleveland, Columbus, Corpus Christi, Dallas, Denver, Durango, Edmonton, Ellinwood, Evansville, Houston, Huntington, Jackson, Kansas City, Lafayette, Los Angeles, Mexico City, New Orleans, Odessa, Oklahoma City, Pittsburgh, San Francisco, Shreveport, St. Louis, Tulsa, Wichita, Winnipeg

TABLE 3. Comparative Gas Lift Test Data Showing Effect of Reduced Flowline Pressure, Delhi Unit, September 1, 1960.

	Two-inch flowline						Four-inch flowline						
	Daily production data						Daily production data						
Well No.	BO	BW	BF	% Wtr.	IGFR	Tubing press.	BO	BW	BF	% Wtr.	IGFR	Tubing press.	Remarks
DU 123-38	4-in. flowline installed initially						173	1328	1501	88	137	65	Casing pressure = 415 psig
DU 179-2	4-in. flowline installed initially						200	1196	1396	86	138	60	Casing pressure = 500 psig
DU 119-3*	5	895	900	99	112	105	250	1400	1650	85	Flowing	60	Reduced backpressure 45 psi—High P.I.
DU 127-13*	5	342	347	71	488	95	24	675	699	97	236	40	Reduced backpressure 55 psi—Low P.I.
DU 155-29*	33	834	867	96	80	150	60	1165	1225	95	70	65	Reduced backpressure 85 psi—High P.I.
					(Avg. IGFR)						(Avg. IGFR)		* Increased oil +291 BOPD. Lowered IGFR from 160 to 70 cu ft/BF. Reduced lifting costs by almost 30¢/BO through depression of IGOR from 7884 to 751 cu ft/BO.
TOTALS* (3 wells only)	43	2071	2114	98	160 cf/BF		334	3240	3574	91	70 cf/BF		
	Avg. IGOR = 7884 cu ft/BO						Avg. IGOR = 751 cu ft/BO						

IGFR = Input gas-to-fluid ratio IGOR = Input gas-to-oil ratio

solute control is unnecessary, jet orifices have been very effective for shallow depth operation.

Several wells have reacted in an unusual manner under active gas lift conditions, as partially demonstrated by Table 2. Within the upper range of water recovery, fluid production of 1000-1100 bfpd approaches what is generally considered the limit for 2-in. tubing and 500-550 psig lifting pressure. Table 2 denotes that the present operation includes three wells which equal this performance, and two of the three DU 119-3 and DU 179-2, approximate 1300 bfpd, substantially higher than might be anticipated, especially in the case of DU 119-3 which operates against considerable backpressure (130 psig) created by flowline size and length. This data accentuates that the Holt-Bryant Zone is very well suited for gas lift application.

Production improved. In addition to surprisingly large fluid recovery with comparatively small quantities of input supply, gas lift has also stimulated vastly improved producing characteristics in some wells. The behavior of DU 179-2, graphically portrayed by Fig. 7, is an extreme and outstanding example of such a response.

This well was recovering about 20 bopd with less than 200 bwpd at the time gas lifting was initiated, April 20, 1959. Subsequent to gas lift, fluid recovery began to steadily increase, but oil production failed to benefit for several months. It was not until September, 1959—some five months later—that a significant change of daily oil production became evident.

Fluid recovery perpetuated its ascent until leveling recently at about 1300 bfpd and, due to an improvement of oil/water ratio, the well is currently delivering 210 bopd with 1100 bwpd (84%) and involves an input gas-to-fluid ratio of only 79 cu ft/bf, Fig. 7. Inasmuch as DU 179-2 exhibited a relatively poor productivity index prior to gas lifting (0.7 bopd/psi drop bhp), the present capability represents an unusual and perhaps unique change of producing potential. It appears that a previously existent bore restriction may have been alleviated with continuous, high velocity withdrawals made possible by gas lifting.

Although the general fieldwide gas lift performance has been highly satisfactory todate throughout the Delhi Unit, many wells, primarily as result of flowline size, length or composition, must be operated against appreciable backpressure (Table 2), a factor which definitely impairs operational efficiency. Therefore, an investigation will be made in the near future to establish if reduced backpressure, possibly available through flowline enlargement, can be economically justified. In conjunction with this study, an attempt will also be made to evaluate the benefits which might be derived from deeper lifting, perhaps utilizing 750-800 psig pressure. It is anticipated that supplementary information such as this will assist the Unit Operator in ultimately arriving at the most economical and effective means for gas lifting suitable wells within the Delhi Unit.

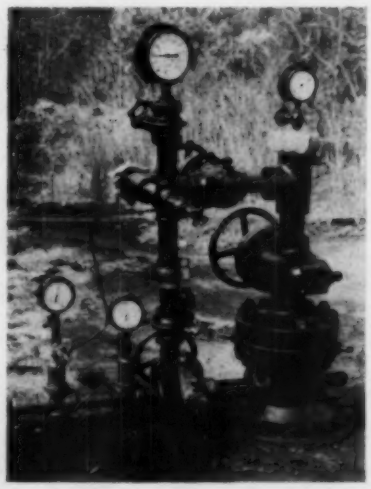


Photo 4. Standardized wellhead hookup for gas lifting producing wells. Gas input is regulated with a removable, positive choke (arrow) between the cross and tee just upstream of casing valve. Pressure gages permit evaluation of the operation.

Reducing Flow Line Back Pressure

Since the completion of this paper, several key wells of the gas lift system which produced into 2-in. diam flowlines of considerable length have been equipped with 4-in. diam lines to minimize backpressure and provide an evaluation of comparative operational efficiency. Table 3 summarizes results of recent field tests, indicating performance of wells originally equipped with 4-in. flow lines, and the comparative performance of three key wells which were originally equipped with 2-in. flow lines and later converted to 4-in. lines. Fig. 8 graphically compares these results for each well tested, the over-all results, and accentuates the importance of minimum back pressure upon gas lift performance.

Although limited information and numerous variables involved with three-phase flow prevent the formulation of definite conclusions suitable for general application, it is obvious that total fluid recovery experienced a significant increase, from 2114 to 3574 bfpd, as well as vastly improved lifting efficiency, as indicated through reduction of the average input gas-to-fluid ratio from 160 to 70 cu ft/bf. As a result, daily oil production from these three wells advanced significantly from 43 to 334 bopd and direct lifting costs were lowered from 31.6 to 3.0¢/BO by depression of the average input gas-to-oil ratio from 7895 to 750 cu ft/BO.

Inasmuch as advanced lifting capacity and improved lifting efficiency stimulated a substantial increase of oil recovery with drastically reduced direct lifting costs, the beneficial aspects of minimum backpressure on gas lift operation cannot be over-emphasized.

Acknowledgment

The author is grateful to Sun Oil Company for permission to publish this discussion, and wishes to acknowledge the photographic assistance of W. L. Orndoff, Sun Oil Company, Delhi, Louisiana, for the photographs used to illustrate this paper. ★ ★ ★

SOLID CONFIDENCE

BUILT ON

SOLID PERFORMANCE

A complete, dependable line of primary cementing equipment available to you . . . "Through Your Supply Store".

LARKIN PACKER COMPANY

DIVISION KOEHRING COMPANY
WAXAHACHIE, TEXAS

LARKIN LEADERSHIP HAS BEEN EARNED BY YEARS OF DEPENDABLE PERFORMANCE

LARKIN
...Through Your Supply Store

for Maximum Efficiency at Minimum Costs . . . in Tubingless Completion

TIW COMPLETION EQUIPMENT

Pioneers in the design and development of tools to effectively reduce well completion costs, by "tubingless" completion techniques, Texas Iron Works presents these thoroughly tested tools designed for maximum efficiency at minimum costs.

TUBING CENTRALIZER

The new TIW Tubing Centralizer enables operator to run multiple strings of tubing, individually, and to maintain proper annular spacing of tubing to insure optimum cementing conditions. The centralizer is designed for easy installation, and maximum performance at minimum cost. Spacing buttons permit maximum circulation with minimum "channeling" of cement.

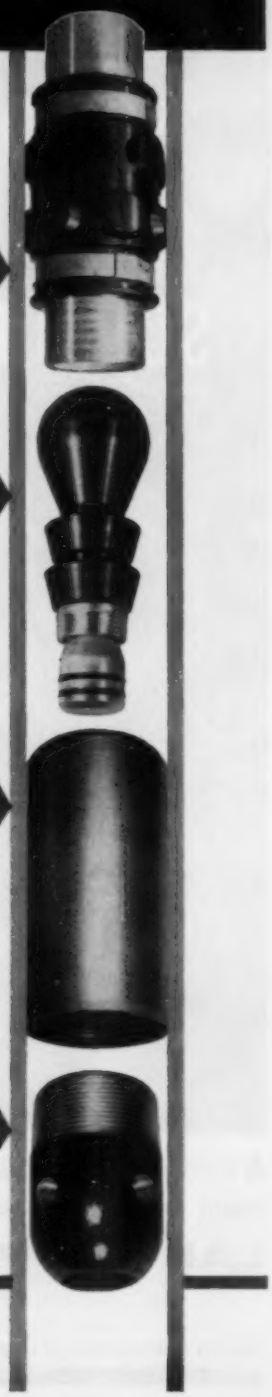
TUBING WIPER PLUG AND LANDING COLLAR

This assembly insures against faulty cementing jobs. The landing collar is placed in the tubing at a point where seal is desired. After cement is pumped into tubing, the wiper plug is placed in the tubing and pumped down until it latches into the landing collar. This gives positive indication that the cement is spotted, tubing is wiped clean, and pressure is sealed off from either direction.

TUBING GUIDE SHOE

The TIW Tubing Guide Shoe, made of tough aluminum alloy to withstand impacts encountered while running tubing, is easily drillable if it becomes desirable to drill it out . . . providing maximum efficiency at minimum cost.

The TIW Tubingless Completion Tools have been thoroughly field tested in numerous West Texas, South Texas and Gulf Coast area wells, providing the utmost satisfaction in economical completion.



TEXAS IRON WORKS

Manufacturers of: T.I.W. Portable Rigs . . . T.I.W. Safety Joints . . . T.I.W. Rotary and Casing Slips . . . T.I.W. Grief Stem Safety Valves . . . T.I.W. Packers for every purpose . . . T.I.W. Pump Chambers . . . T.I.W. Mudmixers . . . and many other oil field tools.

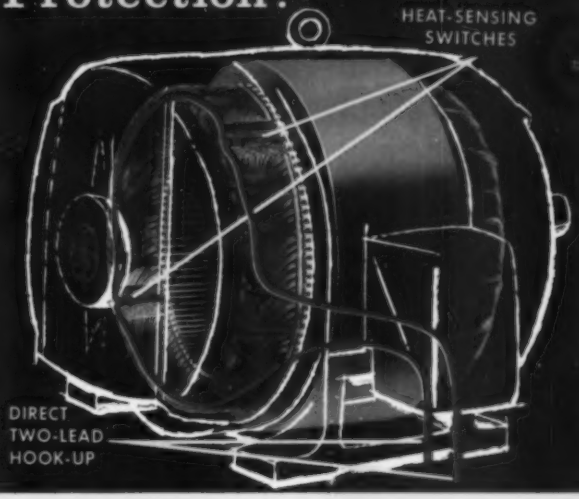
GENERAL OFFICE and MAIN PLANT: 1401-1423 Maury Street, P. O. Box 16068, Houston 22, Texas
Other Shops at Victoria and Corpus Christi
EXPORT REPRESENTATIVE: Val R. Wittich, 30 Rockefeller Plaza, New York, N.Y.
IN VENEZUELA: Oilfield Sales & Service, S. A., Anaco & Maracaibo
IN CANADA: Garrett Oil Tools, Ltd., Edmonton, Alberta

GENERAL ELECTRIC

New Concept in Motor Protection!

Tri-Clad '55' Thermo-Tector

SYSTEM ENDS OVERLOAD BURNOUT!



General Electric offers a *totally new* type of protection on *all* Tri-Clad '55' motors 7½-125 hp!

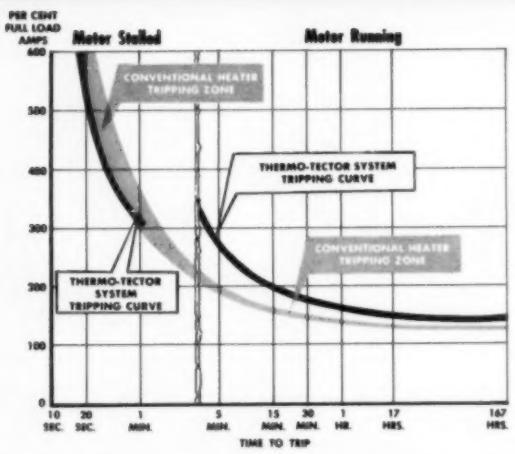
Exclusive THERMO-TECTOR system has heat-sensing switches buried in stator windings. Switches shut off motor *only* when stalls, overloads or other conditions threaten heat damage to motor windings.

Unique THERMO-TECTOR system "anticipation" feature varies motor shut-off point according to rate of winding heat rise. This flexibility allows *maximum motor output* under all conditions.

TURN PAGE FOR FURTHER INFORMATION

NOW! NO WASTEFUL OVERPROTECTION NEEDED ON TRI-CLAD '55' OIL-WELL PUMPING MOTORS!

New THERMO-TECTOR System Allows Maximum Motor Output With No Danger of Burnout



Performance curves show THERMO-TECTOR system's fast response to rapid heat rise (left) and greater motor output allowed under normal run conditions (right).

No wasteful "safety margin" of overprotection is necessary on Tri-Clad '55' oil-well pumping motors equipped with new THERMO-TECTOR system.

This exclusive new inherent protection system has an *anticipation feature* that varies motor shut-off point according to *rate* of winding heat rise. This means you can take full advantage of the special high torque and slip characteristics of the Type KOF motor with no danger of burnout from stalls.

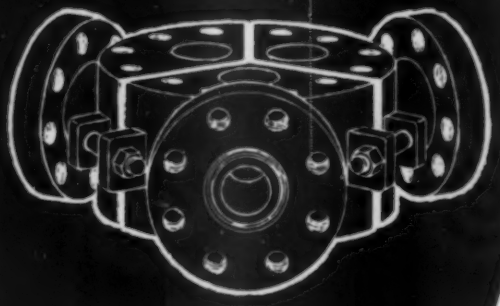
Early or late tripping is eliminated, since THERMO-TECTOR system shuts off motor *only* when stalls, lack of ventilation or other conditions threaten *heat damage* to motor windings.

Tri-Clad '55' motors with THERMO-TECTOR system end need for buying "too much motor." For details, see your G-E Apparatus Sales Engineer or Authorized Distributor, or write for Bulletins GEA-7092 and GEA-6546, Section 874-01, Schenectady 5, N. Y.

SMALL AC MOTOR & GENERATOR DEPARTMENT

GENERAL ELECTRIC

The Ultimate in Flexibility for Triple Completions



TRI FLANGED TEE

THE O·C·T TRI FLANGED TREE

There is *no* doubt about the payout when three good zones can be flowed through one wellhead. There *is* doubt when you use a jumble of complicated equipment.

The O-C-T Crescent Flange Tree is tailored for dual completions. And now we are proud to present the "Tri Flanged Tree" tailored for triple completions.

Like the Crescent, the "Tri Flanged Tree" offers the ultimate in *flexibility, simplicity* and *economy*. One valve in this triple hookup can be removed without disturbing the remaining two valves. Or, if necessary, any two valves can be removed without disturbing the third.

If there is a multiple producer on your horizon, talk to the O-C-T representative nearest you. He can solve your equipment problems before the problems arrive.

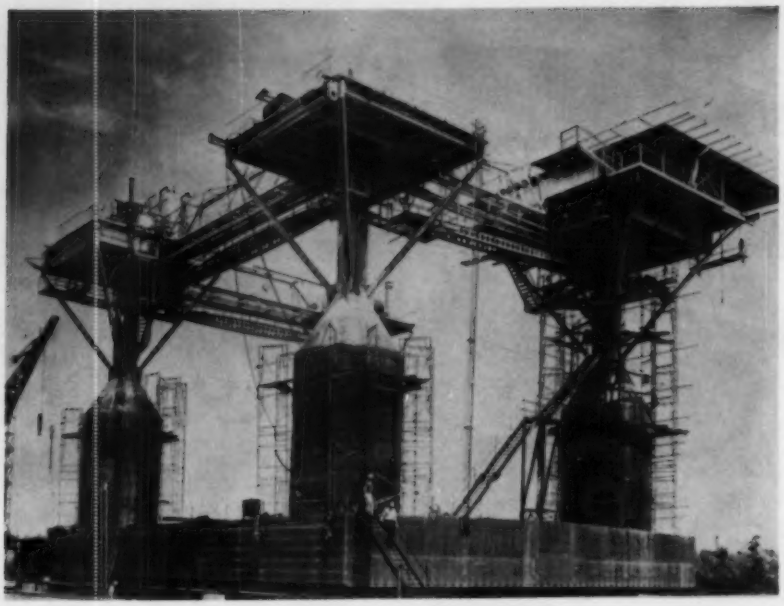
where progress is a daily practice

O·C·T

OIL CENTER TOOL CO.

SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

Address Export Inquiries for All Countries to
P. O. Box 3091, Houston, Texas.



Rectangular base tank and four steel caissons will store 20,000 bbl of crude oil and support living quarters, production facilities, and heliport.

First of its kind . . .

MOBILE UNDERWATER STORAGE UNIT BUILT

FIRST of a new type of mobile underwater oil storage unit was completed recently in Beaumont. Unit will store 20,000 bbl of crude oil 25 ft below the waters of the Gulf of Mexico.

Unit offers a solution to the problem of storing deep-water oil production in sufficient quantity for economic transportation. Basic design of the facility can be adapted to units capable of storing 1,000,000 bbl in water as deep as 200 ft.

Rectangular base tank 112 ft by 92 ft by 10 ft divided into five compartments will rest beneath the water's surface with its top flush with the Gulf floor. To accomplish this, the area where it is to be installed is being dredged 10 ft.

Four steel tubes 18 ft in diameter rise from each of the tank's four corners. Upper sections of the tubes are five feet in diameter, and the tubes provide stability in sinking and raising operations, additional oil storage capacity, and support for four platforms 33 ft above the water, high enough to be safe from hurricane waves.

Pre-assembled unit will be positioned by tug boats and anchors, then flooded with sea water until it comes to rest on bottom. Location will be 35 miles off the coast of Louisiana.

Flow lines from sea-based oil wells 50 to 6000 ft away will be connected to the manifold and the new unit will be ready for operation. As oil flows from the wells at a rate of 2000 bbl a day through the columns into the tanks, the sea water ballast will be displaced.

To discharge the oil, sea water will be pumped in at the bottom and the oil will rise on top of the water to discharge lines. These lines are capable of discharging oil at a rate of over 2000 bbl an hr, and controls prevent oil from being discharged through sea-water system and vice versa.

Units of this type can be towed from one location to another with comparative ease. * * *

— photos courtesy Bethlehem Steel Company

At location in 25-ft water, sea water floods tanks to submerge platform on location. Oil displaces sea water as it enters offshore wells.

NOTHING excels this unit for

AUTOMATIC PRESSURE CONTROL WHILE DRILLING!

THE SHAFFER ROTATING BLOW-OUT PREVENTER AND STRIPPER

has no equal in modern pressure control protection because no other equipment is so versatile... so simple... *so dependable!*

It *automatically* seals off around the drill string when the tools are in the well. You can run drill collars, tool joints, subs and drill pipe through it—going in or coming out—and *the Stripper Rubber maintains its pressure-tight seal throughout all drilling and pipe-changing operations.* Pressure emergencies simply cannot happen too fast for this unit. It is always sealed off until the drill string is removed from the well.

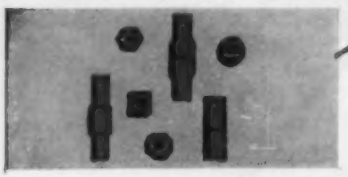
Check over the important features outlined below. You'll find the Shaffer Rotating Blowout Preventer and Stripper ideal for every important drilling requirement!

WEAR-FREE!

The Stripper Rubber rotates with the kelly—not one inside the other. Therefore, flexing and wear are negligible as the drill string rotates. Note that separate thrust and radial bearings (each pre-packed with heat-resisting lubricant) resist any combination of bearing loads!

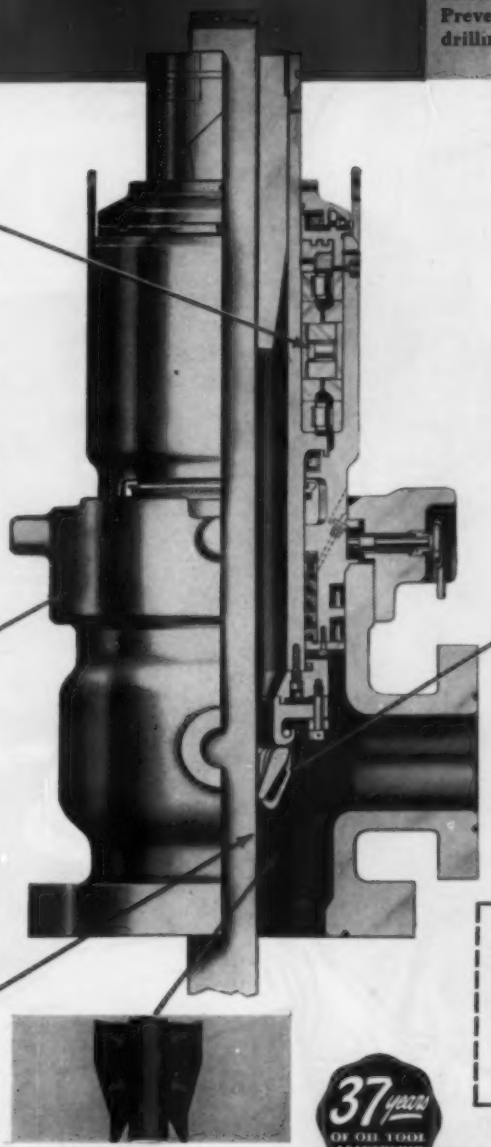
SIMPLE!

To pass bits, reamers and other abnormally-large diameter tools through the unit, simply lower the tools through the body until the rotating assembly seats in place. Then rotate the bonnet 1/6 turn. This locks the entire internal mechanism in place, to provide a continuous seal against well pressures.



VERSATILE!

All the varying diameters in the drilling string—drill collars, tool joints, subs and drill pipe (whether upset, flush or coupled)—readily pass through the Stripper Rubber without loss of pressure—and without any manual adjustments. Even the kelly—whether square, hexagon or octagon—is sealed off *automatically!*

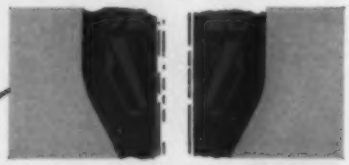


CONTINUOUS!

The Stripper Rubber expands and contracts automatically to fit all normal elements in the drill string (excepting only bits, reamers and similar large diameter tools). No hydraulic, pneumatic or mechanical pressure need be applied. No accessory equipment is required!

COMPACT!

Unit is amazingly compact in all dimensions—can be installed in unusually "tight" locations. Even flow connections are built-in—no space-wasting spools are required!



TROUBLE-FREE!

A barrier of flexible steel latches protects the Stripper Rubber against damage while varying diameters pass through the unit. This expandable steel barrier also protects the rubber from extrusion under high well pressures!

TWO TYPES—Use the Type 50 for drilling through 10¾" casing and larger... Use the Type 51 for slim hole drilling, production and rework jobs. Both have the same basic features!

For further details see your nearest Shaffer representative, or write direct!

37 years OF OIL TOOL LEADERSHIP

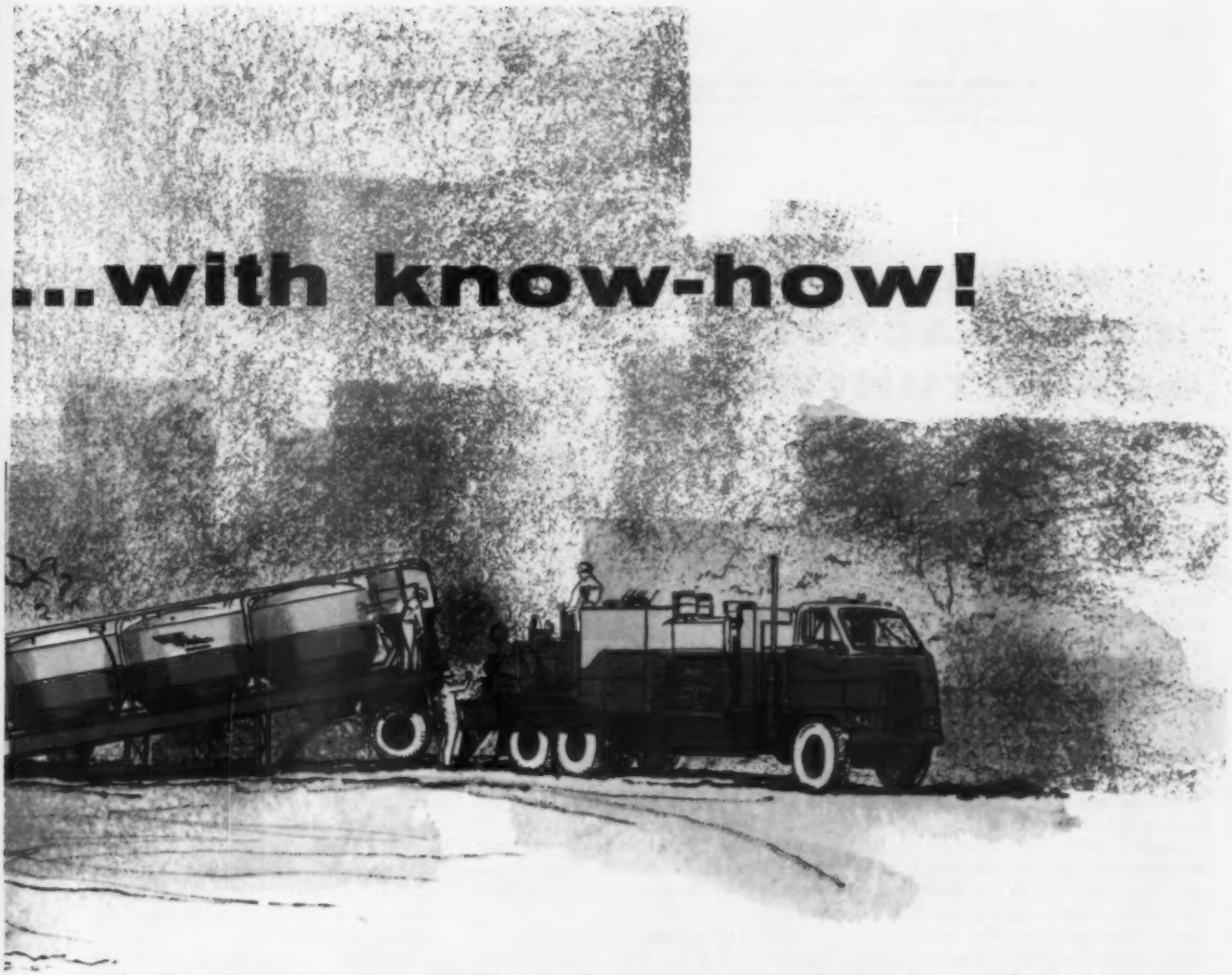
SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

CALIFORNIA SERVICE SHOPS: Santa Fe Springs, Santa Maria, Ventura, Avenal, Bakersfield and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Shaffer Tool Works, 6201 South Shields Boulevard
FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 1788
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 546
HOUMA, LOUISIANA, Shaffer Tool Works, Post Office Box 827
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N.Y., U.S.A.
IN CANADA: Shaffer Western Hemisphere, Inc., 5823 103A Street, Edmonton, Alberta

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

...with know-how!



The three basic ingredients Halliburton depends on to provide you the very best in cementing service are men, materials, and machines. Men who design and operate the machines, and men who develop the materials . . . *these* are the men with cementing *know-how*.

Even more than the modern Halliburton equipment and advanced materials, successful cementing operations are linked directly to the capability of the Halliburton man.

You too can depend on him . . . as everyone has for over three decades!

CEMENTING SERVICES

. . . Where modern oil well cementing begins

Halliburton
COMPANY • DUNCAN, OKLAHOMA

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Dramatic scene taken from the color movie "Under Pressure" is typical of "on-the-job" shots which take the viewer right to the location.

MOVIE HELPS CONTRACTOR'S OPPORTUNITIES

NOW IT CAN BE TOLD. Industrial sound and color movies can and have helped one drilling contractor improve his business opportunities. Tangible evidence in the form of higher revenues and better customer relations sold Paul Rutledge, president, Rutledge Drilling Company of Santa Fe, New Mexico, of the benefits to be gained. Rutledge stated that the company's movie **"Under Pressure,"** produced some two years ago, has been a major factor in increasing business revenue from 1957 through 1959 by 75%. The film clearly demonstrates the methods and equipment hookups used in gas drilling at a time when interest was high on the subject. Since that time, the movie has been shown in many quarters . . . to small and large audiences . . . to any producer expressing an interest to see it. What has it accomplished?

In a recession period when many small drillers have been forced to retrench, Rutledge has added three new drilling rigs to the four he had in 1957. Revenues have climbed from about $1,250,000 to $2,000,000.

In 1959, Rutledge Drilling Company's seven rigs were 80% utilized drilling 40 holes in the San Juan Basin-Four Corners area.

The film to which Rutledge attributes a large and direct part of this success tells the story of gas-drilling a gas well. Gas was supplied by another gas producer and compressed at the rig. Naturally, it was a Rutledge rig that drilled the well in the movie.

Produced for Rutledge by Cinemark II Productions, Inc. of Santa Fe, "Under Pressure" is a full-color 16-mm production and runs 23 minutes.

Rutledge's purpose in producing the film was to explain and publicize gas drilling techniques, how it works and to link his own company with the process.

With major drilling activity beginning in the area, Rutledge said he felt something was needed which would forcefully demonstrate the potential of gas drilling. His own company had sunk holes as much as 10 times faster by gas drilling methods than by using a drilling mud.

Trying to sell both the process where applicable and his firm's services in general, Rutledge said he often ran into closed doors and cool shoulders in major oil firms. "They just didn't know us. That's why we decided upon a mass media to win the interest of a relatively few people," he explains. "We figured that if we could produce a real top-quality film, we would have something of interest and value to the industry. It would build our prestige and tell our sales story."

The film has won several awards in the movie industry for technical and creative excellence. It is unusual in its treatment of an industrial subject because, as Rutledge explains: "While it presents technical information clearly, it also flows from dramatic climax to dramatic climax in a way that defies indifference."

Rutledge said the film paid for itself on the first day after it was completed. That was the day he showed it in the home offices of the oil company which contracted for the well where the movie was made. "Executives whom I had never even been able to meet before were calling me Paul at the end of the day," he explains. "They have given us continuing business." Ever since, Rutledge has used the film as a calling card throughout the industry. "It gives us an entree to the top officials of a company," he adds, "as well as many people in general offices who, while handling matters pertaining to drilling operations, have never actually seen the operation in the field."

Rutledge showed the movie at one sales meeting in Farmington and contracts for six holes resulted. Another time, in San Francisco, a man whom Rutledge said he had never before met was so impressed that he has contracted Rutledge's company to drill all his subsequent New Mexico wells.

"The success of the film lies in its quality," Rutledge believes. "It is prestige we are building."

Rutledge Drilling Company is not the only drilling contractor to use the medium of commercial sound-color movies to gain favorable acceptance of its services. Loffland Brothers Company of Tulsa, Oklahoma, also produced a movie on its world-wide activities. It was shown to a number of oil centers earlier this year. Undoubtedly, there are others who have effectively used movies to not only demonstrate the company's services, but to place the emphasis on information for the viewer.

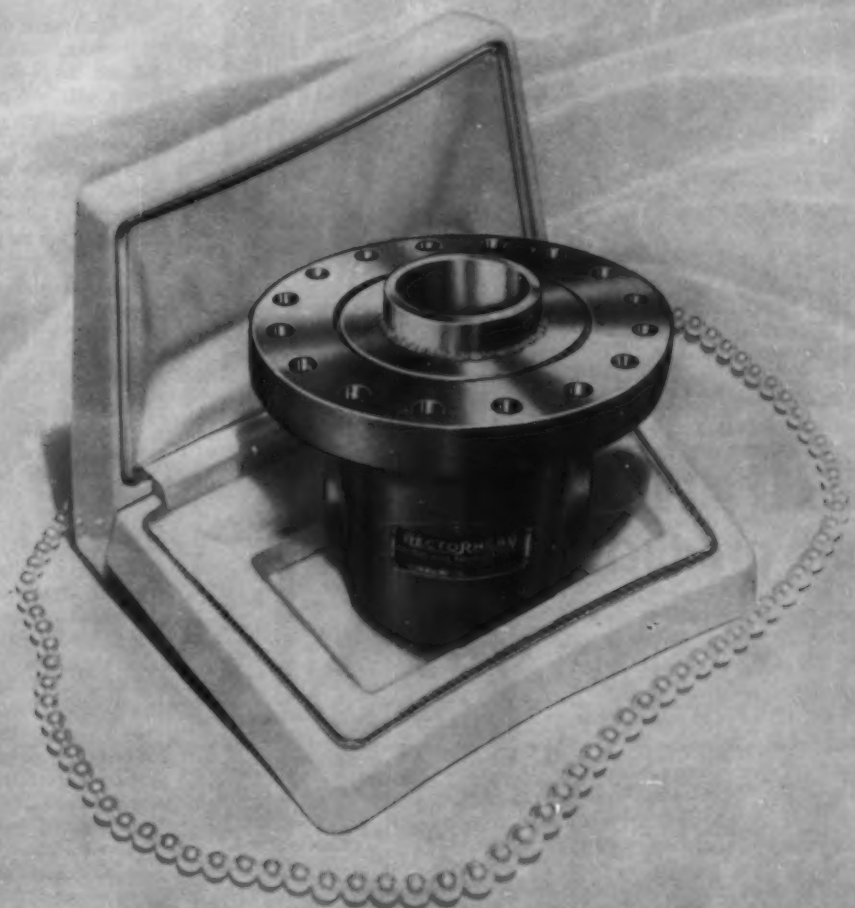
As competition increases, the drilling contractor, somewhat a newcomer in the art of selling his services, will use other means to focus attention upon his ability to do a good job at a reasonable price. ★ ★ ★

Rector

WELL EQUIPMENT CO., INC.

Making the Oil Industry Safer!

30th anniversary



Rectorheads are Sealed with Steel

Well Completed On Ocean Bottom

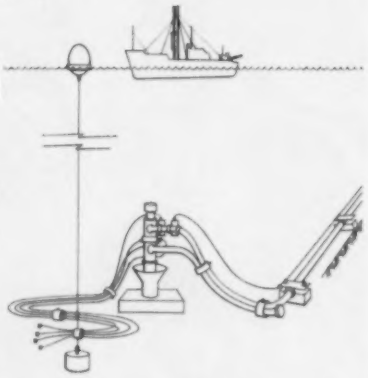
TWO U. S. OPERATORS have successfully completed an oil well on the ocean bottom near the northern coast of Peru. The well, Humboldt 3-3 sits 6200-ft offshore in 132-ft of water near Cabo Blanco.

Wellhead extends only 12-ft above the ocean bottom, and the well produces to tanks onshore through a 3-in. aluminum pipeline anchored to the bottom. Peruvian Pacific Petroleum Company, a subsidiary of Cities Service Company, used the floating drilling barge Rincon to drill and complete the well in a joint venture with Richfield Oil Corporation.

Fabricated in the U.S. of high-alloy steel, operator installed wellhead on location without using divers. Divers only inspected the wellhead, connected pipelines, and installed weights on the flowline.

Operator bundled two aluminum pipelines together and strung them out on the 6200-ft course from wellhead to storage tanks. The 3-in. line delivers oil and gas, and the ½-in. line serves as a hydraulic valve control line.

By using aluminum pipe, operator avoided using heavy equipment such as barge cranes. Winches aboard the drilling vessels pulled the relatively light and highly flexible aluminum into place.



Weights sank the aluminum pipe to the bottom, then divers connected it and put the well into production. It flowed 480 bbl per day of 36.5 deg gravity and then reduced it to 200 bbl per day for more efficient production.

Double seals in wellhead guard against leakage, and a fail-safe valve on wellhead closes automatically unless held open by pressure in hydraulic line.

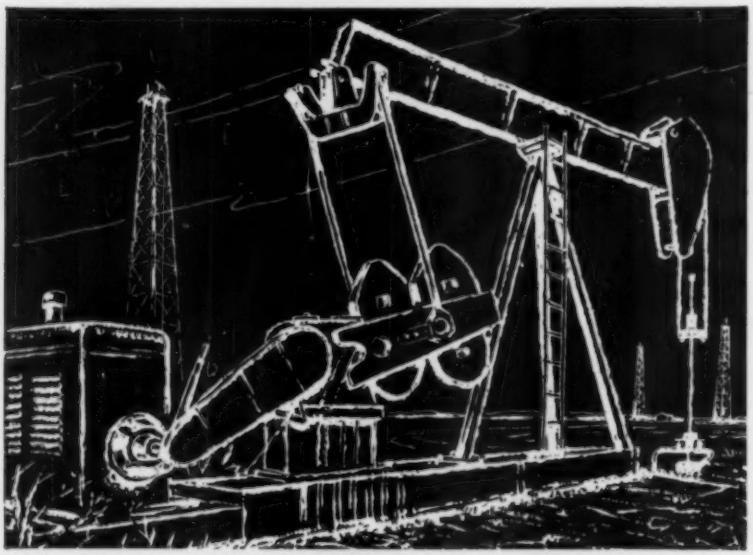
If any oil shows appear on the surface, pumper cuts the hydraulic line off immediately. Should anything cut the flowline, loss of hydraulic pressure would close the valve.

Operator provided for installation of a storm-choke some 200-ft down the hole to shut off production automatically in case wellhead should be sheared off.

Brief tests of oil zones encountered in some of the early wells indicated substantial production, but not of such a nature as to justify the expenditure of millions of dollars necessary to tow heavy constructing equipment thousands of miles to construct platforms and develop the oil reserves using conventional offshore methods.

In addition, some of the zones encountered were so shallow that conventional directional drilling techniques could not be used. Depth of Humboldt 3-3 well itself is about 1000-ft, and the pool cannot be economically produced from a platform at that depth since wells could not be slanted far enough out in such a short vertical depth.

Operator will realize complete success only when wells can be produced to abandonment, through not only the flowing stage but also for the period when the oil must be artificially lifted or pumped to the surface.



PUMPING POWER
means production power!

Production power means time and money saved. Rockford Power Take-Offs are the perfect, controlled power-link between engine and work. These PTO's are used on many oil field rigs, independent power units, and built-in-engines. Next time specify Rockford. Many sizes and types of PTO's and clutches are available. Write today for complete details.

STANDARD ROCKFORD PTO

ROCKFORD CLUTCHES
ROCKFORD CLUTCH DIVISION BORG-WARNER
1303 EIGHTEENTH AVE.
ROCKFORD, ILLINOIS
Export Sales
Borg-Warner International
36 So. Wabash, Chicago, Ill.

A WELL WITHOUT DRILLING... HY-SORB

. . . engineered to stay on line longer!

New, three tower dry-bed recovery unit can pay out in less than a year. Three tower method splits the work-load three ways — adsorption, heating, cooling — each stage at peak efficiency because each tower does only one job at a time.

KEY TO COMPONENTS: ① Inlet scrubber ② Products cooler, ③ ④ ⑤ towers (No. 3, shown on stream), ⑥ Salt bath heater, ⑦ Auto-reflux stabilizer, ⑧ Atmospheric heat exchanger, ⑨ Regeneration gas scrubber.

HY-SORB three tower method eliminates hot pumps, motors, seals and bearings. Simplicity of controls; smaller, more efficient towers; and basic balanced design, cut down-time and maintenance costs.

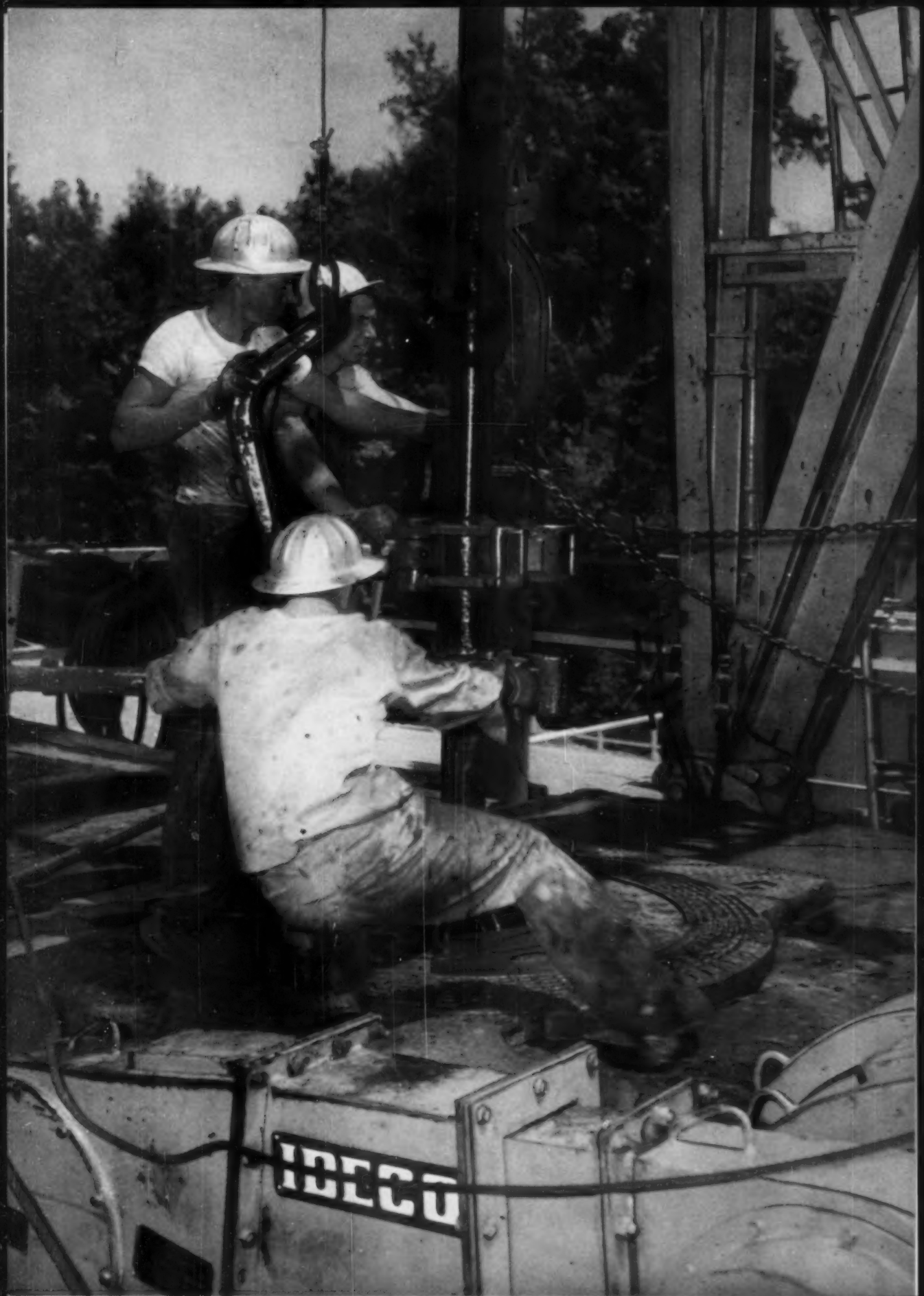
Lowest per barrel recovery costs.
Fastest return on invested capital.

This proven HY-SORB now in operation in the Alco-Mag field 20 miles N. E. Houston

MALONEY-CRAWFORD
TANK AND MANUFACTURING COMPANY, INC.
P. O. Box 659 • 38 North Peoria • Tulsa, Oklahoma, U. S. A.

Write for Bulletin No. HS- 60- B

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD


IDECO

From "Spudding In" to "Bringing In"... J&L Tubular Products Help Cut Running Time

You see a lot of J&L pipe in the oil country. It's specified by top operators who know J&L quality and want to save themselves time and trouble.

Take Drill Pipe, for example. Nearly all your deep hole drilling records have been set with J&L drill pipe. You have grades D, E, Blue Ribbon, and Blue Ribbon Vanadium to choose from. Ends are upset and finished to accommodate flash-weld and shrink-type tool joints.

J&L Grayloc® Tubing is another example. It's held the highest well pressures anyone's hit so far. The Grayloc joints are sealed tight by an independent ring. And the heavy, square threads take the strain of make-up many times without impairing the seal.

On severe, variable drilling operations, J&L Buttress Thread casing gives you joints as strong as the pipe itself. You can put more casing in the hole faster with Buttress Thread casing. You get easier stabbing and rapid spinning, and use fewer power strokes to tighten the coupling.

Look over some rigs where they're using J&L. J&L has invested millions in the finest pipe-making equipment known. J&L has a quality control program as exacting as any in the whole industry. Ask your J&L salesman to prove it . . . he'll be glad to.

Grayloc® manufactured under license from Gray Tool Company, Houston, Texas.
***Extreme Line** produced under license from the Material Supply Company.

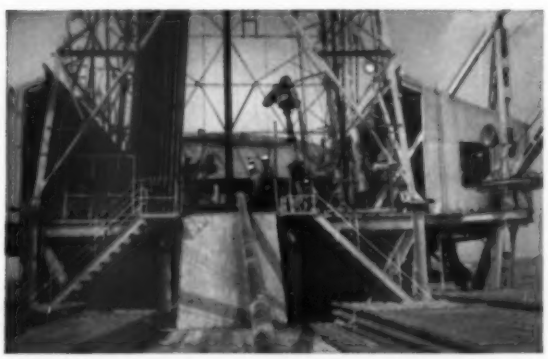
Steel

Jones & Laughlin Steel Corporation

3 GATEWAY CENTER
PITTSBURGH 30, PENNSYLVANIA

Sun Oil Company knows that J&L Grayloc® Tubing provides positive leak resistance at high pressures. J&L Grayloc Tubing can be run again and again. The tubing joint has an independent sealing ring that will hold against the highest well pressures yet encountered.

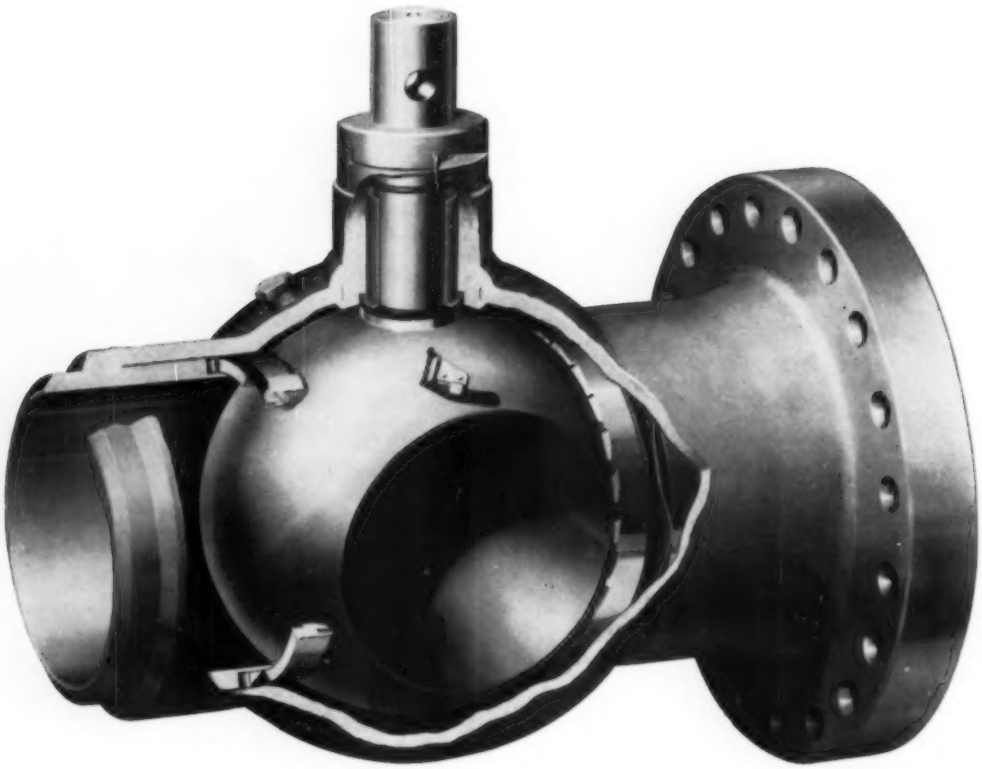
J&L Extreme Line* casing provides maximum joint strength and allows up to 50% higher running speeds than for conventional API T&C casing in the same size and range length.



At Bell Isle Corporation No. 43 well, southwest of Morgan City, La., Sun Oil used 5,813 feet of J&L Buttress Thread casing in the top sections of the 9⅝" casing. "The high strength of J&L Buttress Thread casing was used so a much longer and heavier intermediate string could be run," the drilling superintendent reported.

J&L

STEEL



NEW—FOR GENERAL USE

For Pipe Lines — Chemical, Refining and Gas Processing Plants — Oil Well Drilling and Producing

Cameron

BALL VALVE

with the Exclusive Rotating Seats

These valves handle the most abrasive and corrosive fluids—cannot freeze—cannot develop excessive body pressure; provide up-stream seating, double block and bleed, all with unbelievably easy operation.

They can be supplied in any material, size 2″ or larger to required working pressures and with any type or style of operator desired. The Cameron Ball Valves can be delivered from factories located in United States, Canada, Mexico, England and France.

CAMERON IRON WORKS, INC. — P. O. BOX 1212 — HOUSTON, TEXAS

FPC Decision Reviewed by Investment Group

Several broad conclusions have been drawn from the Federal Power Commission decision in the Phillips Petroleum Company case by Value Line Investment Survey.

At the same time the FPC issued its long-awaited decision, the commission issued a policy statement setting tentative "area prices" for the various producing areas.

It is, of course, too early to measure its impact on individual companies and it is quite likely that this decision will be appealed to the courts.

Nevertheless, the Value Line Investment Survey summarized their conclusions about the decision as follows.

It is probable that the ruling will stand up in court, the survey stated.

"The decision will go a long way toward clearing the confusion that now surrounds natural gas prices. Many of the more than 3000 independent producer cases that have piled up on the commission's docket probably will qualify for automatic control. Many more, involving higher rates, will probably be amended to qualify," the survey stated.

Perhaps equally important, a foreknowledge of what the producer will be able to sell his gas for will encourage him to explore for new reserves.

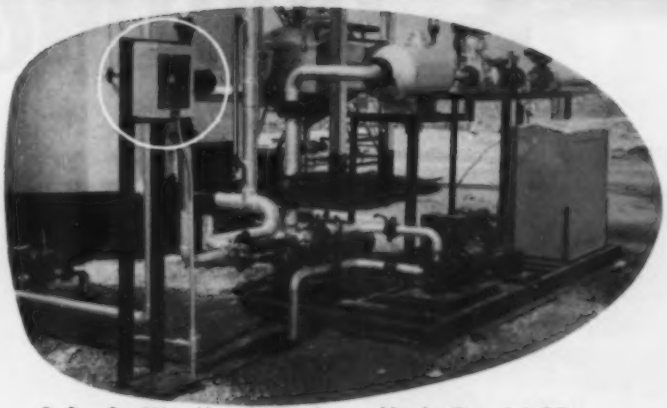
While the decision applies only to independent producers, the Value Line thinks it will be extended to allow the integrated pipe line companies at least the FPC-prescribed maximum rates for existing service for their gas. Otherwise the result will be a higher price to the consumer.

Even if "area pricing" were not extended to the pipelines, they would still benefit from its implementation for independent producers, Value Line stated. Greater certainty regarding prices and elimination of red tape would encourage producers to sell interstate rather than seek intrastate markets even at lower prices. Thus the pipeline's problem in obtaining new gas supplies should become less difficult.

The survey sees the natural gas decision as "a constructive step toward cleaning up the confusion that surrounds national gas rate regulation."

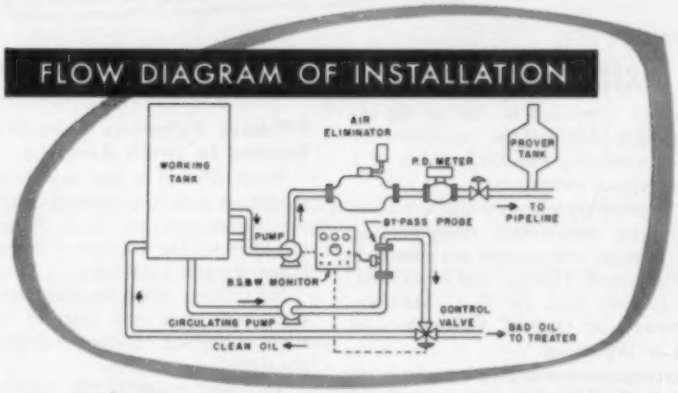
THE MOST IMPORTANT "A" IN LACT

B.S. & W. MONITOR



B.S. & W. Monitor Installed On LACT Pipeline Unit In Osage County, Oklahoma

FLOW DIAGRAM OF INSTALLATION



With the probe installed in-line or in a by-pass, the B.S. & W. Monitor provides continuous inspection and control of b.s. & w. content in crude being delivered to the pipeline. As long as contamination does not exceed setting of Monitor Limit Dial, crude will continue to line. If b.s. & w. content exceeds specifications, Monitor will re-route crude to treater or storage. When crude returns to merchantable condition, Monitor puts it back on line. All this is done AUTOMATICALLY. The B.S. & W. MONITOR MANUFACTURED BY INSTRUMENTS, INC., is the only instrument meeting the specifications for b.s. & w. control as published in the API Bulletin on Automatic Custody Transfer.

SPECIFICATIONS:

Range—From standard 0-3% b.s. & w. to 0-25%
Sensitivity—.05 water contamination
Accuracy—0.1 of 1% water contamination
Power—110 vac, 60 cps
Time Delay—10, 20, 30, 60, 120 or 180 seconds
Probes—2", 3", and 4" flanged, threaded or grooved

INSTRUMENTS INCORPORATED
TULSA

INSTRUMENTS, INC.

BOX 556 • TULSA, OKLA.
PIONEERS IN LEVEL MEASUREMENT AND CONTROL INSTRUMENTATION

What's doing in DRILLING

Rig Designed For Portability With Stable Substructure

—Photo courtesy Continental-Emsco Company.

A new approach to drilling rig arrangement couples the mobility of trailer mounting with the stability of a conventional substructure.

The mast travels on a single trailer, while the drawworks, compounding transmission, and engines are substructure mounted. This rig, first of its kind, was recently built for R. L. Manning Company of Denver, Colorado and Casper, Wyoming.

Arrangement was prompted by a recent R. L. Manning cost analysis of transportation, rig-up and tear-down expenses.

Several features are designed to reduce time between holes. The rotary machine and a portion of the rotary drive guard are permanently mounted in the mast trailer with the rotary chain in place. The telescoped mast travels with rotary line strung and hook block in place. A separate engine-driven wireline reel, built into the mast trailer, quickly unreels and stores the rotary line from the drawworks.

Substructure beneath the drawworks and power end incorporates two conventional sidebox sections for a wide, level working area. The drawworks support trusses connecting the two sidebox sections are of a "swinging gate" type. With the removal of one vertical pin from each, they fold against the side sections for hauling, thus saving time in rigging up and tearing down.

Rig is being completely equipped in Casper, Wyoming, for operation in that area.

Offshore Company Subsidiary Formed in South America

Formation of a new wholly-owned subsidiary, Offshore International, S.A., was announced by T. S. Stoneman, president of The Offshore Company in Baton Rouge, Louisiana.

Subsidiary, a Panamanian corporation, will lease and operate various types of drilling equipment throughout the world.

Two deep water mobile drilling platforms presently operated by the new subsidiary are leased to operators in the Persian Gulf and the Gulf of Paria.

Two Contractors Receive Meritorious Service Award

G. F. McQueen

G. P. Livermore

AAODC Meritorious Service Award designed to pay special tribute to persons who have advanced the science and status of the oil well drilling industry was presented to George F. McQueen, chairman of the board of McQueen & Stout Drilling Company of Fort Worth, Texas, and George P. Livermore, owner of Livermore Drilling Company of Lubbock, Texas.

McQueen's recognition was "in grateful appreciation for long and loyal participation in American Association of Oilwell Drilling Contractor's affairs as a director and committeeman."

Livermore was honored "in extremely deep appreciation of the guidance, counsel, and numerous other valuable contributions which he has rendered to this association through his long, continuous, untiring and faithful service as a director, a member of various committees, as regional vice president, and as national vice president."

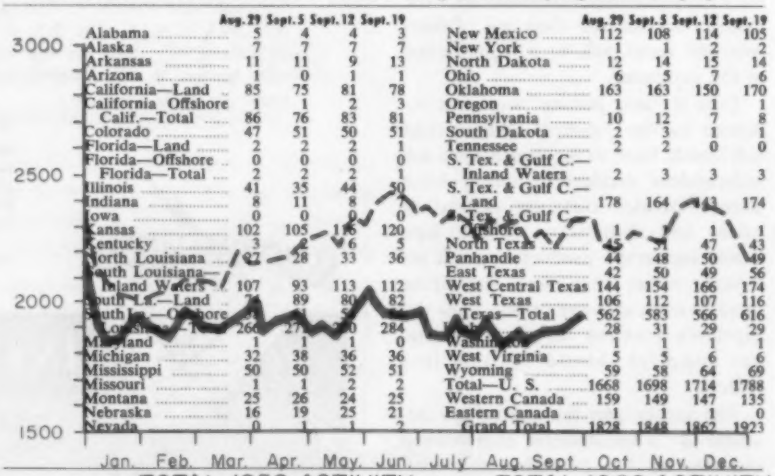
Company Formed To Plan Foreign Air/Gas Drilling

AIRDRILL International, Inc. of Denver, Colorado has been formed to specialize in feasibility studies and pro-

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oil Well Drilling Contractors by Hughes Tool Company.

	Aug. 29	Sept. 5	Sept. 12	Sept. 19
Alabama	5	4	4	3
Alaska	7	7	7	7
Arkansas	11	11	9	13
Arizona	1	0	1	1
California—Land	85	75	81	78
California Offshore	1	1	2	3
Calif.—Total	86	76	83	81
Colorado	47	51	50	51
Florida—Land	2	2	2	1
Florida—Offshore	0	0	0	0
Florida—Total	2	2	2	1
Illinois	41	35	44	50
Indiana	8	11	8	7
Iowa	0	0	0	0
Kansas	102	105	116	120
Kentucky	3	2	6	5
North Louisiana	27	28	33	36
South Louisiana— Inland Waters	107	93	113	112
South La.—Land	76	89	80	82
South La.—Offshore	51	51	57	52
Louisiana—Total	260	273	270	284
Maryland	1	1	1	0
Michigan	32	38	36	36
Mississippi	50	50	52	51
Missouri	1	1	2	2
Montana	25	26	24	25
Nebraska	16	19	25	21
Nevada	0	1	1	2
New Mexico	112	108	114	105
New York	1	1	2	2
North Dakota	12	14	15	14
Ohio	6	5	7	6
Oklahoma	163	163	150	170
Oregon	1	1	1	1
Pennsylvania	10	12	7	8
South Dakota	2	3	1	1
Tennessee	2	2	0	0
S. Tex. & Gulf C.— Inland Waters	2	3	3	3
S. Tex. & Gulf C.— Land	178	164	143	174
S. Tex. & Gulf C.— Offshore	1	1	1	1
North Texas	45	51	47	43
Panhandle	44	48	50	49
East Texas	42	50	49	56
West Central Texas	144	154	166	174
West Texas	106	112	107	116
Texas—Total	562	583	566	616
Utah	28	31	29	29
Washington	1	1	1	1
West Virginia	5	5	6	6
Wyoming	59	58	64	69
Total—U. S.	1668	1698	1714	1788
Western Canada	159	149	147	135
Eastern Canada	1	1	1	0
Grand Total	1828	1848	1862	1923



MAKE CONFIDENT FRACTURING DECISIONS

WITH HALLIBURTON

planning
products
performance

YOUR DECISION

Begin programming your next fracturing treatment by calling in a Halliburton man. He will supply sound, seasoned advice to assist you in making profit-wise decisions.

His suggestions and ideas will represent the best combined thinking of the entire Halliburton fracturing team which is always ready to help *you*.

MULTIFRAC VS SINGLE FRACTURE

Your Halliburton man will discuss *all* the known facts about the well you plan to fracture. Then you can decide whether to select a zone for a single fracture . . . or use one of Halliburton's numerous temporary blocking techniques for multiple fractures. Among the field proven agents offered by Halliburton are *TLC-15* and *TLC-H* which are granular type materials soluble in formation oil and *TLC-W3* for use in water base fluids. *Perfpac* is another method used in perforated casing where specially constructed balls are introduced into the fracturing fluid stream to find and seal perforations — diverting the fluid to other perforations.

For economical, efficient fracturing services, you need all the facts possible . . . get them from Halliburton.

BE SURE YOU GET THE ENTIRE *FRACTURING STORY . . . CALL* HALLIBURTON FIRST!

a working partner
in your fracturing
operation . . . the
HALLIBURTON FRACOMETER
. . . ask about it!

FRACTURING SERVICES

Halliburton
COMPANY • DUNCAN, OKLAHOMA

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

gram planning for air/gas drilling operations outside of the U. S.

Robert W. Sneed, president of the consulting firm, is also a vice president of the parent company, Well Completions, Inc. of Denver. "This company," Sneed said, "could not have been formed two years ago, even though air/gas drilling has been growing in use since 1951."

A rapid spurt in the technology of air/gas drilling — bringing new tools, chemicals, and techniques — has changed the air/gas drilling picture within the last 24 months. Changing conditions in the international petroleum industry increasingly demand maximum economy in dollar expenditures for drilling and development, Sneed said.

In preparing feasibility studies, AIR-DRILL International will be able to draw upon the experience and facilities of the parent company and its other subsidiaries. This experience includes supervising and performing more than 1200 air/gas drilling jobs in the U. S. and Canada.

Two Drilling Contractors Honored For Contributions

Two prominent oilwell drilling contractors were presented plaques for their outstanding contributions to American Association of Oilwell Drilling Contractors at the annual meeting in New Orleans recently.

W. C. Fatjo, owner of W. C. Fatjo Drilling Company of Lafayette, Louisiana, was honored for the outstanding chapter activities of the Lafayette Chapter of AAODC, of which he served as chairman during 1960.

Jas. H. Phillips Jr., president of King-Phillips, Inc., Fort Worth, Texas, was cited as the outstanding chapter chairman for 1960. He has headed the Fort Worth-Dallas AAODC Chapter.

Jerry F. D'Arcy Purchases 10 Drilling Rigs in Alberta

Can-Tex Drilling & Exploration Ltd. has been sold to Jerry F. D'Arcy of Calgary, Canada. He was formerly president of Arrow Drilling Company, Ltd.

Assets of Can-Tex, which formerly was owned by H. W. Bass Sr. and D. W. Harris, include ten drilling rigs located in Alberta. Rigs range in depth of two rigs, 6000 ft; six rigs, 6000 to 8500 ft, two rigs 8500 ft to 13,000 ft.

New company will operate from offices in Calgary, Alberta.

D'Arcy will be president of the company, and other officers named are F. C. Mannas, vice president and manager of operations; G. W. Watkins, secretary and treasurer; and John Morris continues as general drilling superintendent.

Most Slim Holes Drilled Use 6¾-in. Bit

The greater percentage of slim holes drilled used a 6¾-in. bit, a survey conducted by American Association of Oilwell Servicing Contractors found in reports from 185 companies.

Average maximum depth of holes drilled was 6580 ft, and average minimum depth was 3115 ft. Average depth of all holes was 4515 ft.

In actual operations, the depth of the holes ranged from 550 ft to 11,856 ft. Hole size of slim holes drilled or completed ranged from 2¾-in. to 9⅞-in. bit size.

Eight-inch Hammer Drill Shows Drilling Promise

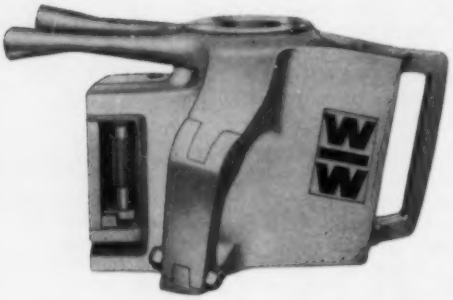
In reporting developments on air/gas drilling, three authorities pointed out that an 8-in. hammer drill has been designed and field tested in 4500 ft of drilling in a difficult area. Operation was essentially trouble-free mechanically, and means were devised to insure steady operation, conferees at annual meeting of American Association of Oilwell Drilling Contractors were told.

Tool drilled 1⅓ to 2⅓ times faster than conventional rotary air and added 30 to 60% to bit life. Initial trouble with breakage of large bits was over-

"Matched Tools for Unmatched Performance"

Web Wilson "CHAMPION" Elevators Do the Job Easier

The working advantages of the Web Wilson "Champion" elevator can be clearly seen on any rig. *Superior Balance* allows elevators to roll easily in the links. Better balance reduces the need for a balancing strap. The *Slanted Hinge Pin* makes closing easier and under loaded conditions transfers a portion of the force from the latch to the hinge. *Forward Swept Link Arms* permit easier handling in picking up and laying down pipe.



For increased crew efficiency and reduced costs, put a "Champion" elevator to work. Available in both collar and taper types to handle pipe from 2⅜" thru 5½".

CASING ELEVATOR

Other elevators with the desirable safety latch feature in the Baash-Ross line of "Matched Tools for Unmatched Performance" include the H-50 and H-150 elevators for casing, and the C-30 and C-65 elevators for tubing.

TUBING ELEVATOR

For additional information see a Baash-Ross representative, or your supply store.

Call us for Your *Rental and Service* Needs
. . . available in most areas.

OUR 42d YEAR OF PROGRESS

BAASH-ROSS

DIVISION OF JOY MANUFACTURING COMPANY

General Offices: Houston, Texas

come, and suitable percussion rock bits are now available.

In another development, percussive air and gas drilling has been successfully extended to hole sizes as large as 13¾ in. In limited tests, the large hammer drill using light weights and high rotary speed, successfully reduced hole deviation and maintained straight hole in an area where deviation trouble is common.

Hammer drills are now commercially available in the Mid-Continent and Appalachian areas and in Canada for drilling holes up to 13¾-in. in diameter.

Presenting their study were J. E. Eckel, Jersey Production Research Company; A. S. Murray, Humble Oil & Refining Company, Carter Division; and W. E. Liljestrand, Mission Manufacturing Company.

Negotiations Underway For Largest Mobile Unit

Universal Drilling Company is negotiating with offshore oil operators for the lease of the proposed "Emile Brinkmann," a drilling barge that has been designed by the company. It will be the largest piece of similar equipment in the world, when it is completed.

At the same time, negotiations with a shipyard for the construction of the barge have been almost completed. This phase is delayed until the lease contract is completed.

Barge as designed, equipped with two derricks, and outfitted to work in 300 ft of water, will cost about $6,000,000.

Several innovations have been incorporated into the design. One is the pair of 200-ton rotary lifting cranes, which can be moved out on each side of the 82-ft-wide drilling slot and can be utilized to set well jackets and production platforms.

Slot will be completely enclosed with a water jacket which will keep the steel cool in case of fire and be equipped with a fire fogging system.

There are 40 watertight compartments and ample storage for both mud and cement.

The leg design calls for eight vertical stems. These will be used when the rig is put into position. After the unit has been set in place and jacked up to the desired height above the water, then four additional legs will be lowered and set at an angle of 17.5 deg off vertical, to give the barge stability.

Rig Fire Prevention, Control Covered in API Publication

"Fire Protection in Drilling Operations," a new booklet, has been announced by the American Petroleum Institute.

Publication includes measures taken to prevent fires as well as measures taken to minimize, control, or extinguish fires which occur.

Average Cost of Drilling, Equipping Well Increases

Average cost of drilling and equipping a well in U. S. increased from $17,900 in 1939 to $44,100 in 1954 and $51,600 in 1958.

This 20-year increase of almost 190% is reported in the newly-released Census of Mineral Industries issued by the U. S. Department of Commerce. Report featured complete 1958 statistics on costs, depths, number of wells drilled, crude oil and natural gas production, offshore operations, contract drilling, service industries, etc.

Census reported a total footage drilled of 193,700,000 ft compared with 210.8 million in 1954. The total cost of drilling and equipping wells in 1958 was $2425 million, an increase of 5% from 1954. Oil wells cost $1,310,000; gas wells, $441,000,000, and dry holes and service wells, $674,000,000.

Of the total cost for drilling and equipping wells, $1,005,000 was paid to contractors. The $1,420,000 borne by operators was distributed as $733,000,000 for drilling, $385,000,000 for casing, and $302,000,000 for flowing and pumping equipment.

"Matched Tools for Unmatched Performance"

BAASH-ROSS TRUBORE DRILL COLLARS

. . . SUPERIOR QUALITIES Keep Them FIRST!!

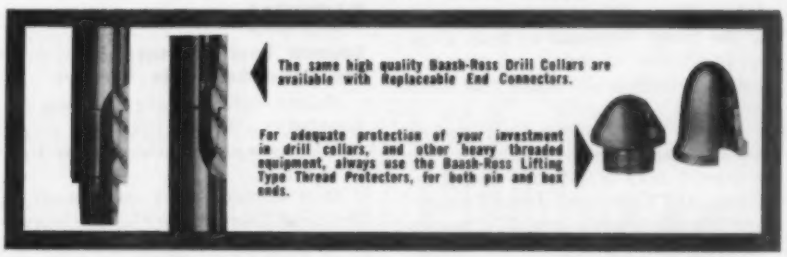
Baash-Ross Drill Collars are stress relieved to prevent bending in operation due to internal stresses.

Specified chemical analyses and heat treat processes result in mechanical properties 1" below the surface which insure maximum joint strength.

Impact tested to assure attainment of the desired metallurgical characteristics.

Thru the years these qualities of Baash-Ross Drill Collars have proven to be essential for maximum Collar life.

For additional information, write for Bulletin D1


The same high quality Baash-Ross Drill Collars are available with Replaceable End Connectors.
For adequate protection of your investment in drill collars, and other heavy threaded equipment, always use the Baash-Ross Lifting Type Thread Protectors, for both pin and box ends.

Call us for Your *Rental and Service* Needs
. . . available in most areas.

OUR 42d YEAR OF PROGRESS

BAASH-ROSS

DIVISION OF JOY MANUFACTURING COMPANY

General Offices: Houston, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

EXPLORATION ACTIVITIES

ALASKA

Independent Brings in Second Kenai Gas Field

First commercial gas field to be discovered by independents in Alaska was brought in by Alaska Oil & Mineral Company, Halbouty Alaska Oil Company, and King Oil Company.

Well was tested at an open flow of 80,000,000 cu ft per day of dry gas from perforations between 4992 and 5020 ft.

New field, designated West Fork gas field, is located on the Kenai Peninsula 16 miles east of the Union Oil-Ohio Oil gas field and six miles south of the Soldatna oil field of Richfield and Standard of California. A gas pipe line is now being built by the Alaska Pipe Line Company from the Kenai fields to Anchorage, Stennard and other installations.

Kenai Peninsula Wildcat Abandoned With No Shows

Halbouty Alaska Oil Company has abandoned its second Kenai Peninsula wildcat in Alaska but is testing the third for gas.

Bishop Creek unit 11-11, nine miles west of Swanson River field, has been plugged at 9034 ft. It had no shows of either oil or gas.

ALGERIA

Franco Delhi Awarded Large Rhourde Hamra Permit

Franco Delhi, a wholly-owned subsidiary of Canadian Delhi Oil, Ltd., and its associates, have been awarded a second large concession in Algeria by the French government.

Group has been given a permit to explore for oil and gas in the 1,047,820-acre Rhourde Hamra area of the Sahara Desert, about 120 miles south of the Hassi Messaoud oil field. Closest production to the permit area is a gas and distillate discovery four miles away.

Franco Delhi is operating partner for a syndicate which includes El Paso Natural Gas Products Company; Home Oil Company, Ltd.; Petropar and Francarep of France; E. Constantin Jr.; Allen & Company and Vaughn Brothers.

BOLIVIA

Discovery Well Flows 325 BPD Near Santa Cruz

An oil discovery has been made by Gulf Oil Corporation in their Zone 1 acreage in Bolivia.

The discovery well, Caranda No. 1, located about 30 miles northwest of the city of Santa Cruz, flowed 325 bbl per day of 50 deg gravity oil through ¼-in. choke from perforations at 5850 ft. A lower interval also tested oil of similar gravity and other shallow prospects have not yet been evaluated.

Gulf has about 1,200,000 acres under concession in this general area, and drilling of the discovery structure will be continued to evaluate its significance.

CALIFORNIA

Exploratory Well Spudded In Robbins Field Acreage

Occidental Petroleum Corporation spudded in an exploratory well on its 5000-acre block in the Robbins Field.

Designated as Robbins Unit A-1 and located in Sutter County at the northwest corner of Section 21, Township 12 North, Range 2 East, the well will be drilled to a total depth of about 7500 ft.

Occidental will explore the F zone in the Upper Cretaceous formation in which the company, at nearby Arbuckle, recently drilled nine successful producing gas wells without a dry hole.

New California Platform Starts Drilling Operations

Drilling operations have commenced on Hilda, Texaco, Inc.'s second drilling platform offshore from California, which was placed in position in June.

Western Operations operates the two big platforms, including the first platform Helen, on the Summerland lease in partnership with Humble Oil & Refining Company.

GEORGIA

Second Test in State Set For Lake Seminole Waters

Humble Oil & Refining Company has spudded in a 4500 ft test in the waters of Lake Seminole in the southwest tip of the state.

Well location is 2.9 miles north of Woodruff Dam on the Florida-Georgia border. Barge rig is being moved to drill site from New Orleans in the Gulf of Mexico and the Apalachicola River.

GULF OF SIRTE

Marine Seismic Survey Set for 6,700,000 Acres

Marine seismic exploration has begun on Atlantic Refining Company's 6,700,000-acre concession in the Gulf of Sirte, offshore from Libya in the Mediterranean Sea.

Libyan government granted the concession to Atlantic earlier this year, and the Libyan Atlantic Company has been set up as a wholly-owned subsidiary of Atlantic to conduct the exploration program.

Headquarters for LAC are being established in Tripoli, some 200 miles west of the westernmost point of the Atlantic concessions.

Concession follows the Gulf of Sirte shore line and distance from one end to the other is about 400 miles. Outer limits of block range from 25 to 50 miles offshore with water depths ranging from zero to more than 900 ft.

Atlantic also plans to run a marine seep survey on the concession at the same time, using the company's marine "sniffer." It has been automated and installed on the seismic boats.

IOWA

First Discovery Reported Pumps 45 Bbl of Oil

A second cable tool wildcat pumped 45 bbl of oil in 15 hours near Cresco in Howard County, Iowa, reported Hans Jesperson, vice president of Saratoga Development Corporation.

Well contains two zones of production, Jesperson said, one in Devonian at 420 ft and the other in Ordovician at 872 ft. Gravity of the oil is estimated at 38 deg.

Saratoga plans two more cable tool wells in the area, Jesperson said, and they will be staked soon.

Should well remain commercially productive, it will place Iowa as the thirty-fourth oil state.

NEBRASKA

Eight Wildcats Planned On 35,000-Acre Tract

An attempt to develop production to the east of the four-county Cambridge Arch field will be made by Joe Josephson, a Dallas, Texas operator. Eight wildcat test wells in Buffalo, Dawson, Furnas and Gosper Counties will be drilled on acreage farmed out by British-American Oil Producing Company.

Josephson will acquire a 5000 acre checkerboard interest in 43,000 acres through drilling the four Buffalo wildcats and an undisclosed amount of checkerboard acreage in the other counties.

Spudding first well was planned right

this well is misbehaving

One of the most significant and directly useful "products" of Core Lab's new *CAP* service — COMPUTERIZED ACCOUNTING OF PRODUCTION — is the reporting of abnormal well behavior.

Not only does *CAP* deliver complete, tailormade production summaries (by zones, wells, batteries, leases, fields, and interests) but special reports can be issued when variations occur in well test, production, or injection characteristics. The client specifies the tolerances when his program is designed. *CAP* takes it from there. It's quick and simple, accurate and economical.

This feature alone makes *CAP* worth looking into.

NEW LITERATURE AVAILABLE. *Forward request on your company letterhead to Core Lab, Box 10241, Dallas 7, Texas. Please mention name of this magazine.*

CORE LABORATORIES, INC.

BOX 10185 DALLAS 7 TEXAS USA • CABLE ADDRESS CORELAB

CORE LAB

DALLAS ABILENE AMARILLO BAKERSFIELD BARTLESVILLE CASPER CORPUS CHRISTI DENVER EL DORADO FARMINGTON FORT WORTH HATTIESBURG HOBBS HOUSTON JACKSON KIMBALL LAFAYETTE LIBERAL LONG BEACH LOS ANGELES LUBBOCK McALLEN MIDLAND MONAHANS NEW ORLEANS OKLAHOMA CITY PAMPA PECOS ROCK SPRINGS ROSWELL SAN ANTONIO SHREVEPORT STERLING TULSA TYLER VICTORIA WICHITA WICHITA FALLS WILLISTON WORLAND CALGARY EDMONTON REGINA BOGOTA BUENOS AIRES FYZABAD MARACAIBO PORT OF SPAIN TRIPOLI ALGIERS PARIS

Another plus value:

Inherent Lubricating Qualities Broaden Use of Seeco-Mul As E-P Additive

Seeco-Mul Also Affords Faster Penetration, Extends Life of Bits, Collars, and Liners

On your next well, try Seeco-Mul Drilling Mud Additive as an extreme pressure additive. Many operators have recently discovered this extra advantage in Seeco-Mul; in fact we can show you data on a number of field wells drilled under almost identical conditions that will convince you that Seeco-Mul is the most effective E-P agent you can use.

The efficiency of Seeco-Mul as an E-P agent is due to its chemical structure — the ability of one end of the Seeco-Mul molecule to adhere tightly to a metal surface, attracting another molecule to form the familiar micelle, or the joining of two molecules at opposite ends. This layer attracts other Seeco-Mul molecules, which build up to an extremely tough lubricating film that is difficult to remove and will withstand high pressure, successfully reducing metal-to-metal contact and subsequent wear, or galling, of the bearing surfaces.[1]

In addition to the E-P qualities, you get many other advantages with Seeco-Mul. Inasmuch as Seeco-Mul is a chemical emulsifier with superior wetting abilities, it is often run in so-called "soap" drilling fluids (the addition of detergents to fresh water muds, oil-and-water, and water-clay systems) to lower the surface tension, thereby wetting the formation ahead of the bit and keeping the bit clean. Such systems also afford a faster penetration rate and aid the suspended solids to drop out in the pits.

Too, with good lubricating qualities in the mud, less drill stem torque is required, pump pressures can be lowered and more evenly sustained, and a higher velocity of the fluid on bottom can be obtained . . . all of which means longer service life for liners, collars, tool joints, drill pipe, and the bits themselves.

Add to this the longer bit runs and the consequent savings in bits and rig time and you will agree that adding Seeco-Mul to the system is an investment rather than a drilling expense.

Let us show you how you can use Seeco-Mul profitably. We'll gladly send you illustrated literature and a lab sample of Seeco-Mul, or contact your local mud dealer. You can get full particulars without obligation.

[1]McCutcheon, John W., "Synthetic Detergents."

Make a good mud better . . . use

CROSSETT **Seeco-Mul** **DRILLING MUD ADDITIVE**

Manufactured by the Chemical Division of The Crossett Company, Crossett, Arkansas

Seeco-Mul is the dried flake form of a compound of the sodium salts of abietic, linoleic, and oleic acids, together with quantities of wood tannins and lignins.

away in C NE SW 3-10-18e and it will be followed with drilling a C NW NE 11-9n-15w, C SW NE 18-12n-17w and C NE SW 9-11n-18w, all in Buffalo.

The other projects will be in C NW NW 10-9n-19w, and C SE NW 26-9n-20w, both in Dawson County; C NW NE 11-4n-21w, in Furnas County, and C NW SE 14-5n-21w in Gosper County.

NEVADA

Rank Wildcat Well Planned in Elco County

Richfield Oil Corporation intends to drill a rank wildcat in northern Nevada, which has previously been unexplored. Well will be located some 18 miles north and slightly east of Tuscarora on the Bull Run Structure of Elco County.

NEW MEXICO

Lea County Wildcat Well Shows 277 Bpd Potential

A southeastern New Mexico wildcat oil discovery with a production potential of 277 bbl per day was brought in by Tennessee Gas and Oil Company, the domestic and Canadian oil and gas division of Tennessee Gas Transmission Company.

On a potential test, the Number 1 USA — G. E. Jordan flowed naturally at a rate of 34.65 bbl of 43-gravity oil in three hours on a ⅜-in. choke. Production is from the Delaware sand at an interval of 4628 to 4702 ft. Total depth drilled was 4805 ft.

The well is in Lea County, New Mexico, about 30 miles southeast of Carlsbad, and is approximately seven miles north of the nearest previous production, which is in the El Mar and Mason North fields.

OKLAHOMA

Renewal Wildcat Strikes Gas, Oil in Major County

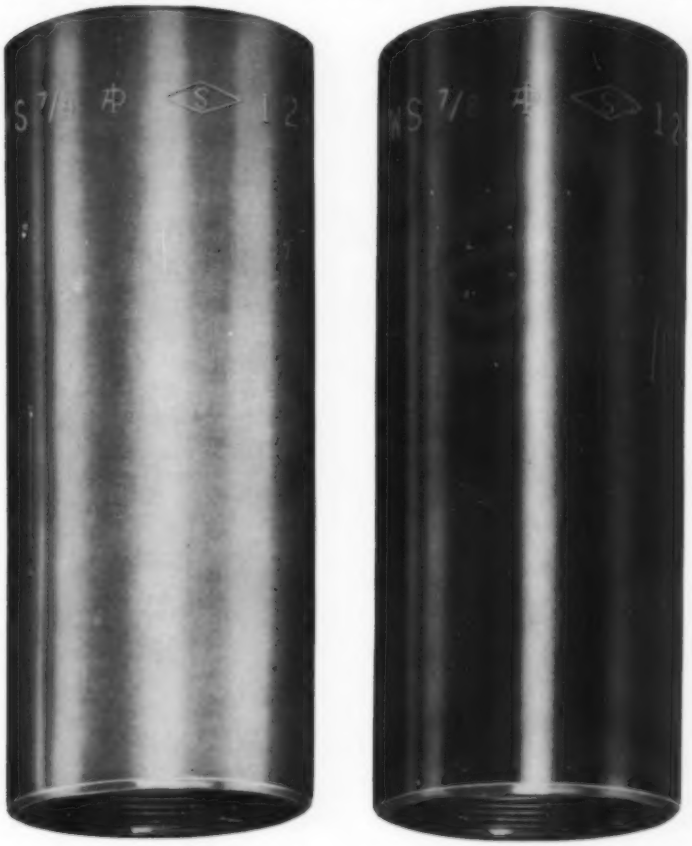
Pan American Petroleum Corporation has completed a renewal wildcat for prolific gas and oil in Major County.

Pan American's wildcat, the No. 1 Barnes gas unit, NE SW 29-23n-15w, in Major County, northwestern Oklahoma, had an initial potential flow of 9,100,000 cu ft of natural gas, with 832.65 bbl of 41-gravity oil per day from Hunton perforations at 8041 to 8044 ft.

During another test the well, which is five miles northeast of the West Campbell pool, flowed 312 bbl of oil in 49 hours on a 12/64-in. choke with tubing pressure of 2400 lb and casing pressure of 2600 lb.

Well was drilled and abandoned by

"Oilwell" Sucker-rod couplings machined from leaded alloy steel at high cutting speeds and finished on a centerless grinder. Couplings are shown *before* and *after* heat treatment.



USS leaded Alloy Steel bars speed up machining...produce a superior finish.

This sucker-rod coupling is a good illustration of how **leaded** alloy steel in the annealed condition can increase machining speeds, produce more parts per hour, and assure an exceptionally fine finish. Cutting tools don't have to be changed as often, threads are smoother and the ends machine accurately. ☐ The steel used in the coupling is leaded, an Open Hearth, Ni-Mo Leaded Steel. Cutting speeds of 268 to 313 r.p.m. were used with an .007" feed producing 550 to 900 couplings before having to change cutting tools. Other users have reported production increases of about one-third over unleaded alloy steel. ☐ If you are looking for a superior product, we urge you to try USS Constructional Alloy Steels, such as 4140, 4145 or 8620 with lead. In addition to good machining, you get high resistance to abrasion and corrosion, better finish and longer product life. ☐ You can obtain USS Leaded Alloy Steel bars and semi-finished steel in all the usual sizes of rounds, squares, hexagons and flats. If the leaded alloy grade you need is not listed here, write or call the nearest office of United States Steel or write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS is a registered trademark

Steel — This mark tells you a product is better because it's steel.

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

USS

THE MARK OF INTEGRITY.....

This is our trademark.

It tells you the product

is made by Hughes.

Behind it stands a pledge

that gets right to the point:

Any product with this mark

will deliver the best

performance you can buy!

HUGHES TOOL COMPANY *ORIGINATOR AND WORLD'S LEADING DEVELOPER OF CONE-TYPE ROCK BITS*

How one operator used D-Gassers to

reduce gas well costs by about $55,000

A Canadian operator — drilling deep gas wells in the Alberta foothills — is using the SWACO D-Gasser to save about $55,000 per well. Here is how he does it:

This operator, who was developing a gas field in the Alberta foothills, was encountering a gas-cutting problem during drilling that increased costs seriously. The problem was high-pressure, low-volume gas accumulations in a shale section above the main pay or between pay zones.

Until this shale section was reached, mud weight of 10 pounds per gallon was carried. When this section was being penetrated, however, severe gas cutting and "blowing" occurred. The gas cutting then persisted in the form of a two to three hour trip gas for the remainder of the well.

Practice before using D-Gasser

The operator circulated until he could build mud weight up to 11-13 pounds per gallon to control the gas cutting. Lost circulation in the pay section frequently occurred with the heavy mud, and a great deal of lost circulation material was often required. The cost of mud materials to control both gas and lost circulation ran $25,000 or more per well.

Initially, it took anywhere from two days to a week to condition the mud, and in one case it was necessary to set casing before drilling could proceed. In addition, several hours of rig time were lost after each trip gunning out the trip gas.

Practice when using D-Gasser

With a D-Gasser installed, the operator merely starts it up when the gas cutting occurs. Occasionally the preventers have to be closed, and the well placed on choke for a few hours. However, the whole job of mud conditioning can be accomplished in less than one day without increasing the mud weight. Moreover, penetration rates and bit life while drilling using the lower weight muds are substantially improved. Total savings in drilling costs amount to approximately $30,000 per well.

To summarize, the operator has found he saves $25,000 or more in mud costs and something like $30,000 in rig time and other drilling costs.

This case is just one of many examples that prove the SWACO D-Gasser is more than just a safety device to be used for wildcat drilling. It makes possible important reductions in overall well costs in any area where gas cutting is a problem. Contact your nearest SWACO representative to find out just how much D-Gassers can reduce your costs. Also ask him how SWACO Clayjectors and D-Sanders can further reduce drilling costs.

SWACO

SALT WATER CONTROL, INC.
1809 CONTINENTAL NATIONAL BANK BLDG., FORT WORTH 2, TEXAS
Telephone: EDison 2-4433 Cable Address: "SWACO" Fort Worth

LOUISIANA: New Orleans, Lafayette • TEXAS: Houston, Corpus Christi, Fort Worth, Kermit
OKLAHOMA: Oklahoma City COLORADO: Durango

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Pan American at 7286 ft in July of 1958. During renewal operations, crew drilled to 8293 ft, plugged back to 8120 ft and set 4½-in. casing at 8137 ft.

PAKISTAN

Three Wells Drilled Below 11,000 Ft Depth

A vigorous search for oil in East Pakistan has resulted in three test wells drilled simultaneously to depths below 11,000 ft. The three test wells are Lalmai No. 2, a joint Pakistan Petroleum-Pakistan Shell venture; Pakistan Shell's Rasidpur No. 1; and Stanvac's Hazipur X-1.

Lalmai No. 2, being drilled by Pakistan Petroleum was spudded in on May 10. Despite a few drilling problems resulting in loss of time, steady progress was maintained to 11,892 ft.

Pakistan Shell's Rasidpur No. 1 test was spudded in on February 22 and has reached a depth below 12,600 ft. The pipe stuck and efforts are being made to recover all or part of the fish before drilling is resumed.

There have been some indications of gas in higher formations, and these zones will be tested later.

Hazipur X-1, Stanvac's second test in East Pakistan, began drilling late in March and had reached final depth, 12,516 ft, by the end of August. This well has now been abandoned as a "dry hole."

PERMIAN BASIN

33 Oil, Gas Strikes Hit With 44 Dusters in Month

Twenty-six oil and seven gas discoveries were completed in the West Texas-New Mexico area comprising the Permian Basin, during a four-week period ending August 27. Wildcat dry-hole completions during the period totalled 44, giving an impressive strike-to-dry hole ratio.

In the same period of the preceding year, 19 discoveries compared with 66 failures.

Twelve of the August strikes were in Southeast New Mexico, and for the second successive month, Lea County set the discovery pace for other basin counties with one gas and five oil discoveries.

TEXAS

Lower DeWitt County Yields Deep Edwards Lime Field

One of the most significant finds in Texas's mid-coastal region this year is discovery of a new deep Edwards lime field.

New field in southwestern DeWitt County, is more than 15 miles nearer the coast than any other field on the Deep Edwards trend.

Discovery well, Texas Eastern Transmission Corporation's 1 Harman A. Garbe, produces gas and condensate from a 29 ft zone at 13,881 to 13,910 ft. Gas flow through ¼-in. choke tested 2,720,000 daily under pressure of 1850 psi. Condensate was not gaged.

Pay zone of well is in upper Edwards, and it is first production in DeWitt County from Cretaceous age. Nearest Cretaceous production is in Persons fields, Karnes County, adjoining DeWitt on the west.

Two deeper zones in the lower Edwards were also tested, one at 14,054 to 14,576 ft and the other from 14,593 to 14,452 ft. Both showed gas, but no completion was attempted because of water.

2480 Ft Gulf Coast Well Yields 95 MMcfd of Gas

On open flow potential, a Shell Oil Company discovery flowed at a rate of 95,000,000 cu ft per day. G. A. Musselman "B" 5 in the Helen Gohlke field of Victoria County near the Gulf Coast was completed through perforations at 2974 to 2980 ft in a Frio Sand.

Rugged and trouble-free 30-hp **WISCONSIN ENGINE** powers portable shot hole rig

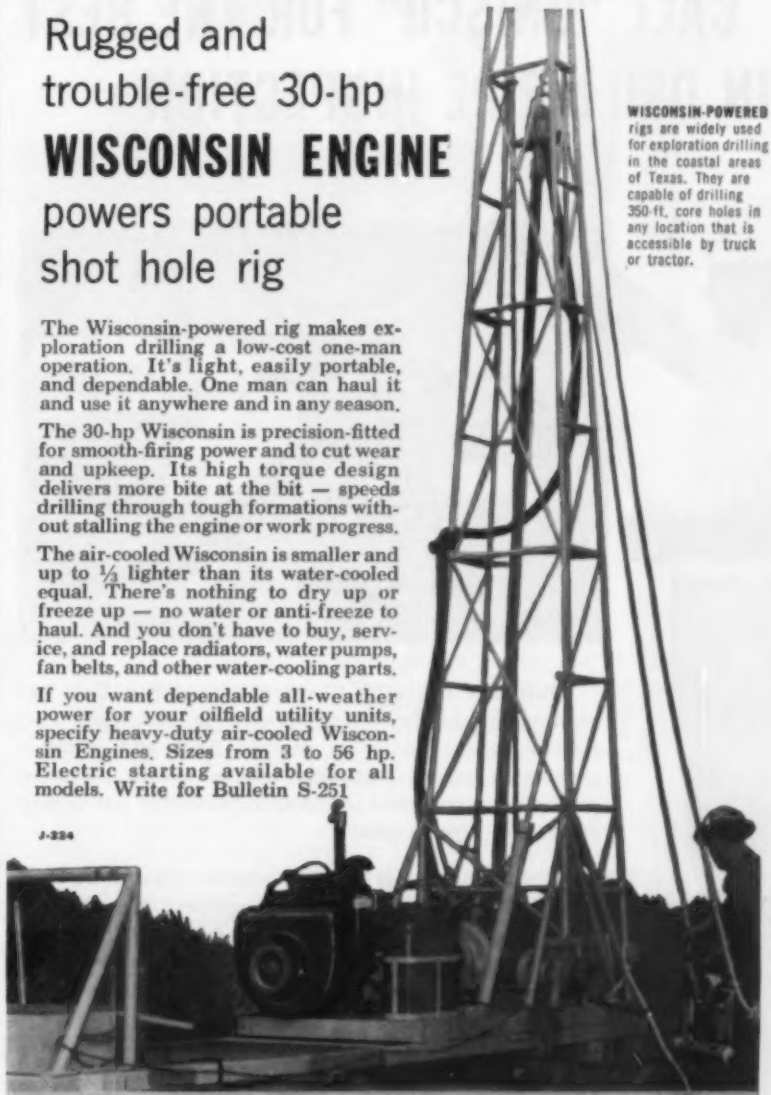
The Wisconsin-powered rig makes exploration drilling a low-cost one-man operation. It's light, easily portable, and dependable. One man can haul it and use it anywhere and in any season.

The 30-hp Wisconsin is precision-fitted for smooth-firing power and to cut wear and upkeep. Its high torque design delivers more bite at the bit — speeds drilling through tough formations without stalling the engine or work progress.

The air-cooled Wisconsin is smaller and up to ⅓ lighter than its water-cooled equal. There's nothing to dry up or freeze up — no water or anti-freeze to haul. And you don't have to buy, service, and replace radiators, water pumps, fan belts, and other water-cooling parts.

If you want dependable all-weather power for your oilfield utility units, specify heavy-duty air-cooled Wisconsin Engines. Sizes from 3 to 56 hp. Electric starting available for all models. Write for Bulletin S-251

J-234



WISCONSIN-POWERED rigs are widely used for exploration drilling in the coastal areas of Texas. They are capable of drilling 350-ft. core holes in any location that is accessible by truck or tractor.

WISCONSIN MOTOR CORPORATION
Milwaukee 46, Wisconsin

WRITE TO HARLEY SALES CO.
610 SOUTH MAIN STREET • TULSA, OKLAHOMA
6420 McKINNEY AVENUE • HOUSTON, TEXAS
500 SOUTH MAIN STREET • WICHITA, KANSAS
Oil Field Distributors for Wisconsin Engines and all types of Utility Units

World's Largest Builders of Heavy-Duty Air-Cooled Engines

Non-Upset Tubing Joint Features Buttress Threads

New non-upset buttress-thread tubing joint developed by National Tube Division of United States Steel Corporation has several space-strength characteristics.

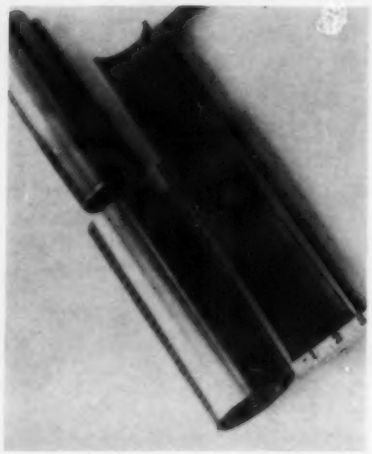
Thread design is applied to plain end, non-upset tubing. Pipe and couplings can be stabbed together on normal drop impact without thread damage or cross-threading.

Design features maximum well clearance with full inside diameter to assure maximum flow, and it simplifies field handling since pipe can be easily re-threaded in the field.

Pipe-coupling joints can be made up and broken in the field a minimum of 12 times without thread damage. Threads in couplings are tin-plated to assure maximum protection against leakage, designed to withstand pressures up to 15,000 psi and also to reduce make-up torque and tonging.

Joint strength is about 98% of pipe body strength.

New development reflects oil industry's efforts to attain deeper well depths in the face of higher formation pressures, thus increasing requirements for



tension strength, leakage resistance and small diameters for tubing joints.

Prior to the buttress thread application, tube ends had to be upset in order to have the joint strength equal to the tube body strength.

Threads have a 0 deg pulling face and a 45 deg flank angle on the compression side with broad, flat roots and crests parallel to the major axis of the pipe. This thread form and length of threaded section are the major factors contributing to the strength of the joint. The flat crests and roots and tapered design are important features for easy make-up.

Resistance to gas leaks is obtained by thread tolerance and thread length in addition to heavy tin plating on coupling. The electro-tin plating (0.0020 average) also reduces make-up torque and tonging.

Tubing is presently available in J, N and P grades in sizes 2⅜ and 2⅞-in. OD. Other sizes will be available at a later date.

CALL "UNISCO" FOR THE BEST IN DRILL PIPE INSPECTION

This new UNISCO Electronic Inspection Unit has been made possible by new advances in electronics. This electromagnetic induction method finds and prints a permanent record disclosing fatigue cracks, corrosion pitting, or outside and inside surface defects which may cause drill pipe failure.

The unique design of the electronic circuits are such that the operator is signaled the moment any phase is not operating perfectly. *No more dry runs. No more reruns. No more overlooked defects!* Trailer mounted, this unit can be used in yards, the field, or easily transported to marsh or water locations.

No other method or type of unit does as thorough an inspection.

UNIVERSAL INSPECTION & SERVICE CO.

A Division of Atlas Pipe Inc.

Houston GY 9-9250, New Iberia EM 4-8666, Odessa EM 6-8241

SPE Names Top Officers

E. M. Kipp

L. E. Elkins

Earl M. Kipp will be 1961 president of the Society of Petroleum Engineers of American Institute of Mining, Metallurgical and Petroleum Engineers, taking office in February 1961. Lloyd E. Elkins will become president-elect in 1961 and serve as president in 1962. Kipp is special consultant — producing problems on the staff of the vice-president in charge of producing for Standard Oil Company of California in San Francisco. Elkins is chief engineer for Pan American Petroleum Corporation.

SUPPLIERS' PARADE

New Companies, Subsidiaries And Agents

The **Axelson Division of U. S. Industries Canada, Ltd.,** has opened an Axelson pump shop specializing in pump and sucker rod sales and service in Estevan, Canada.

Bradford Motor Works, Inc. has purchased the capital stock of Chas. N. Hough Company, Franklin, Pa. Plant facilities of Hough will move to Bradford. Hough's Tulsa warehouse will be maintained.

Crest Instruments, a division of Magna Products, has signed an exclusive agreement with the Pure Oil Company to manufacture and sell corrosion measuring equipment under Pure's patents.

Eastman Oil Well Survey Company has acquired McGaffey-Taylor Corporation with the immediate objective of expanding the line of washing and cementing tools made by McGaffey for sale here and abroad.

Kern County Land Company formed a new subsidiary, Gas Processors, Inc., to design/produce portable, skid-mounted, gas-treating units that remove liquids from natural gas on the lease.

Lane-Wells Company, one of the Dresser Industries, Inc. has opened 2 new service locations — Woodland, California, and Ruston, Louisiana — and a new district office — Perry, Oklahoma.

Major Eng'neering Company appointed Jones & Laughlin Supply Division exclusive distributor for their automatic lease equipment in the U. S. and Canada.

Merla Tool Corporation has appointed Spalco Engineering Service, Ltd. as their Canadian distributor.

Monarch Engineering Corporation announced the establishment of their new warehouse in Tulsa as a distribution point for the Mid-Continent area. F. C. Cummings, manager of Mid-Continent dealer sales.

Reed Roller Bit Company purchased all outstanding stock in Electrodynamic Instrument Corporation. The purchase fits into Reed's announced plan to acquire industrial concerns not necessarily allied with the petroleum industry.

Universal Inspection & Service Company is making their inspection service for oil field tubular products available in Canada through the facilities of Atlas Bradford Co. of Edmonton, Alberta.

Appointments and Promotions

Atlas Pipe Inc. — **L. T. (Lex) Shackelford,** Houston city sales staff.

Baash-Ross Division of Joy Manufacturing Company — **DeWitt T. Dees,** district sales representative, Shreveport, Louisiana.

BJ Service, Inc., one of the Borg-Warner industrial group — **Robert F. Meiklejohn,** reassigned to BJ after three years special assignment to Borg-Warner.

Bowen Itco, Inc. — **A. T. Johnson,** district manager, Oklahoma City; **Tommy Farr,** district manager, Houston.

Harold Brown Company — **Pat Childs,** sales manager.

Bucyrus-Erie Company — **Eugene P. Berg,** executive vice president, formerly general manager of Chicago operations of Link-Belt Company.

PRODUCING SLIM-HOLE?
RUN A
HARBISON-FISCHER

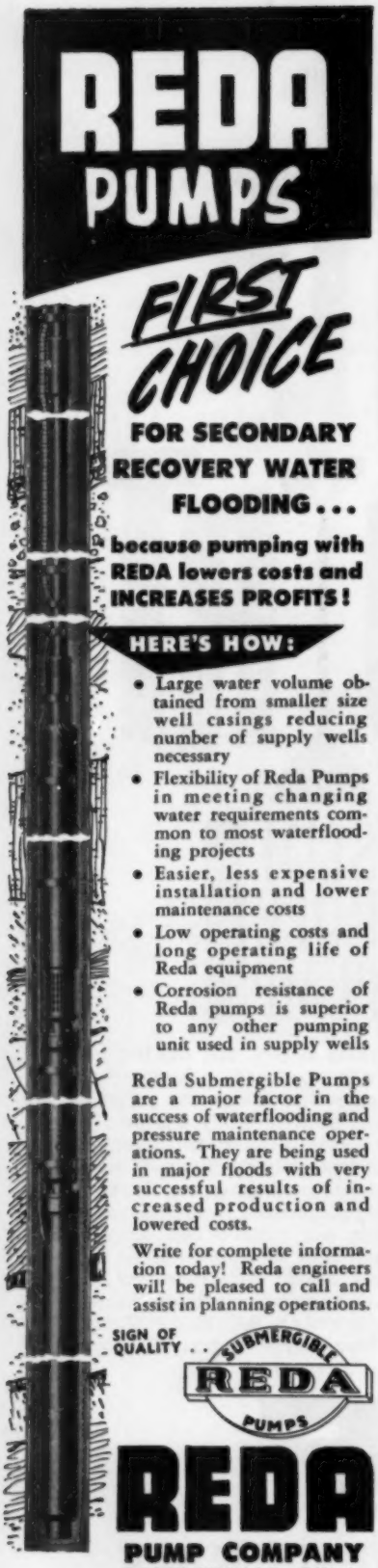
LITTLE SQUIRT
SLIM HOLE PUMP

With domestic allowables and markets as they are, the trend is toward slim-holes . . . for completing in new areas . . . for marginal wells . . . and for fully exploiting pays that are on the verge of depletion. Little Squirt Pumps have been carefully designed to afford all of the operating advantages desired in small-volume production . . . with the stamina and dependability of regular-sized pumps. Whether you complete single- or multiple-string, there's a Little Squirt available . . . four in rod pump sizes, including hollow rod types, and five tubing pump sizes, with metal or cup plungers.

Try a Little Squirt in your next slim-hole. It's another pump that Harbison-Fischer has designed for a special application that you can run with confidence—because you know that Harbison-Fischer will stand behind it. Ask your store, or write to P.O. Box 2477, Fort Worth, for illustrated literature. There's no obligation, of course.

HF
"BEST PUMPS IN THE OIL PATCH"

HARBISON-FISCHER MFG. CO.
FORT WORTH


REDA
PUMPS
FIRST CHOICE
FOR SECONDARY RECOVERY WATER FLOODING . . .
because pumping with REDA lowers costs and INCREASES PROFITS!
HERE'S HOW:
• Large water volume obtained from smaller size well casings reducing number of supply wells necessary
• Flexibility of Reda Pumps in meeting changing water requirements common to most waterflooding projects
• Easier, less expensive installation and lower maintenance costs
• Low operating costs and long operating life of Reda equipment
• Corrosion resistance of Reda pumps is superior to any other pumping unit used in supply wells
Reda Submergible Pumps are a major factor in the success of waterflooding and pressure maintenance operations. They are being used in major floods with very successful results of increased production and lowered costs.
Write for complete information today! Reda engineers will be pleased to call and assist in planning operations.
SIGN OF QUALITY . . .
SUBMERGIBLE
REDA
PUMPS
REDA
PUMP COMPANY
BARTLESVILLE, OKLA.

Byron-Jackson Division Borg-Warner Corporation — **E. R. Koberg,** vice president, headquarters in London, England; **E. S. Dulin** retired as chairman of the board.

Catawissa Valve & Fittings Company— **Craig L. Davis,** president.

Clark Bros. Co., one of the Dresser Industries — **John W. Jennings,** sales representative-small engines, Houston; **John L. Spencer,** application engineer, Houston; **James O. Campbell,** application engineer, Los Angeles.

The Colorado Fuel and Iron Corporation — **R. L. Hanes,** general manager of tubular sales.

Continental-Emsco Company — **William G. Clark,** store manager, Rangely, Colorado; **Albert N. Taylor,** store manager, Hadacol Corners, Texas.

Cummins Engine Company, Inc. — **C. R. Boll,** executive vice president, marketing; **R. W. Franck,** vice president, sales.

Grove Valve and Regulator Company — **E. C. (Early) Bird,** district sales manager, Houston, formerly division manager for Gulf Coast Machine & Supply Company.

Gulf Coast Machine and Supply Company — **J. B. (Jake) Waltermire,** representative in Lafayette, Louisiana.

Houston Oil Field Materials Co., Inc. — **B. R. Wakefield,** vice president, Special Projects; **R. R. Nagel,** director of manufacturing, engineering, research and development, formerly with Texas Instruments, Inc.

Hughes Tool Company—**T. E. (Travis) Parish,** assistant to the general manager.

Ideco Division of Dresser Industries, Inc. — **J. C. Young,** manager, Ideco Division, Dresser Italy, in Rome; **W. L. (Bill) Farrow,** manager, Ideco Division, Dresser Ltd., in London; **Shannon L. Matheny Jr.,** New York export manager.

Jones & Laughlin Supply Division — **R. J. Bevington,** store manager, Freer, Texas; **R. S. Allison,** store manager, Lake Charles, Louisiana.

Joy Manufacturing Company—**George R. Fox,** vice president, Joy International S.A.; **John W. Johnson,** manager, oil field compressor sales; **C. A. Patten,** works manager, New Philadelphia, Ohio.

Liberty Manufacturing Company of Texas — **John H. James,** president; **W. R. Pardue,** secretary-treasurer.

Magnet Cove Barium Corporation — **B. Q. (Jack) Green,** retiring as chief service engineer, will serve as consultant.

Morse Chain Company — **Robert J. Koch,** Southwest regional sales manager.

National Supply Company — **Herbert L. Willke,** director of engineering; **Kenneth W. Dudley,** chief engineer, Torrance, California, plant, replacing **Forrest J. Young** who retired after 43 years service; **Joseph R. Mahan,** retired as director of research engineering after 38 years.

Oil Center Tool Company — **Charles T. Jones,** general manager; **A. C. West Jr.,** sales manager.

Oil Well Supply Division, U. S. Steel Corporation — **E. E. Stanley,** district representative, Denver; **Earl L. Bundy,** area manager-production equipment sales, Evansville, Indiana; **W. E. Willis,** district engineer, Clay City, Illinois.

Republic Steel Corporation — **Forrest H. Ramage,** manager of sales, pipe division, succeeding **J. W. Owings,** who has withdrawn for health reasons.

Rolo Manufacturing Company—**Walter Henry,** assistant general manager and elected to board of directors; **Ross B. Baze,** vice president-sales. Baze is former vice president and director of the Delta Tank Manufacturing Company.

Schlumberger Well Surveying Corporation — **J. T. Douglas,** sales manager, Louisiana Gulf Coast division.

Tex-Tube, Inc. — **Norton Moore,** project engineer.

Trinity Steel Co., Inc. — **Dillard Cantrell,** assistant to the president.

Tube-Kote Inc. — **J. W. Bozeman,** chairman; **E. G. Holm,** president; **J. L. McConn,** vice president - assistant treasurer; **R. S. Martin,** vice president - operations; **L. C. Edgar,** vice president - technical manager; **I. D. May,** treasurer - assistant secretary.

Union Wire Rope Corporation — **John M. Fry,** sales representative in Western Oklahoma and Texas Panhandle.

The Western Company — **Harold E. Parsons,** vice president, South American division with offices in Buenos Aires; **Donald Walters,** division manager replacing Parsons in Farmington, New Mexico; **Laddie Harp,** division sales manager, Oklahoma City, Also announced:

Dr. Ernest Dale, Ithaca, N.Y.; **Charles S. Leonard,** Chicago; **J. S. Brown,** Fort Worth; and **Roscoe C. Clark,** Fort Worth; elected to board of directors. Brown is Western's secretary-treasurer and manager of finance division, Clark is vice president and manager of engineering and research.

Republic Supply Company—**Walter J. Slaughter,** district manager of Oklahoma district.

Southwestern Industrial Electronics— **Col. George B. Kaiser,** USAF (Ret.), appointed manager, planning programs.

Tex-Tube, Inc.—**C. S. Hightower,** field engineer for Gulf Coast area, transferred to company's Dallas offices.

General News

A. O. Smith Corporation will break ground in mid-1961 for a $2 million advanced research center at Middleton, Wisconsin. The new labs will be devoted to advanced fields of solid state physics and physical chemistry, as well as the energy processes involved in the utilization of such materials.

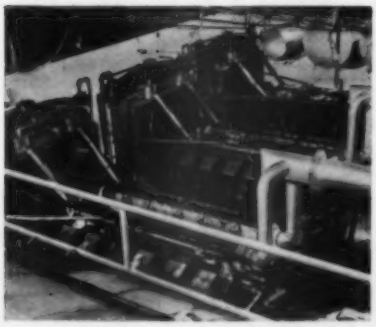
The Petrolite Corporation has been honored with a Meritorious Safety Award from the National Business Aircraft Association for an outstanding aircraft safety record. In ten years 3,051,380 miles have been flown without accident.

Butler-Larkin Company, Inc. is new name of Larkin and Company, Inc. and all production facilities of the company have been transferred from Butler, Pennsylvania to Wellsville, New York. New plant facilities will provide a much larger production area, efficient production layout, ample parking facilities, and improved plant working conditions. Company will continue to manufacture present line of oil, gas, and special well production equipment.

Raytheon Company has under development an electronic oil well heater which may aid in recovery of some of the vast oil reserves which cannot be brought to the surface by present methods. Raytheon engineers are working with Petro-Electronics Corporation of Denver, whose engineers are contributing their geological and oil production experience to the program. Study is directed toward producing a unique system employing special electronic generators of very high frequencies, in the microwave band. Microwaves emitted are designed to provide quick-acting, penetrating heat that petroleum engineers seek.

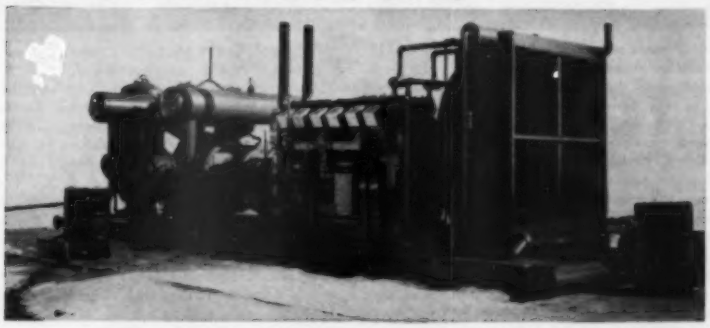
it's CLIMAX

for DRILLING and PUMPING

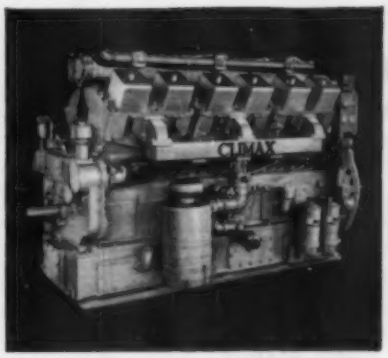


● Climax Engines have proven their reliability in hundreds of oil field installations. Single, well balanced design, rugged construction, and quality materials make them smooth running . . . for years!

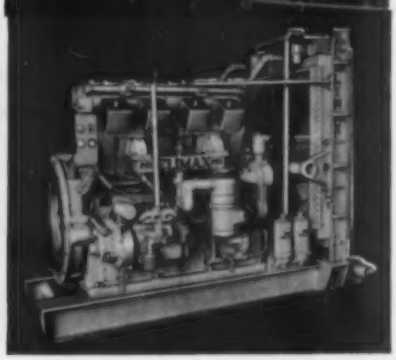
for COMPRESSORS



Model K-67—Max. hp 265 (Natural Gas)



Model V-125—Max. hp 605 (Natural Gas)



Model V-85—Max. hp 390 (Natural Gas)

CL-116

CONT. DUTY (NAT. GAS) →			DRILLING-PUMPING (80% RATINGS)						COMPRESSORS (65% RATINGS)				
Model	Bore & Stroke	Displ.	Peak Torque @ RPM	Brake hp at Speeds Indicated					Peak Torque @ RPM	Brake hp at Speeds Indicated			
				600	800	900	1000	1100		800	900	1000	1030
R-165	6¼ x 7	1238	684 @ 750	81	105	117	127	135	557 @ 800	85	95	103	105
K-67	7 x 7	1616	955 @ 850	110	145	161	176	188	775 @ 800	118	131	143	146
K-75	7½ x 7	1855	1090 @ 800	126	166	185	204	218	885 @ 800	135	151	166	169
V-80	7 x 7	2155	1240 @ 850	140	188	210	230	246	1002 @ 800	153	171	187	190
V-85	7½ x 7	2474	1460 @ 800	164	223	246	266	284	1185 @ 800	181	200	216	221
V-122	7 x 7	3232	1920 @ 800	217	293	328	353	378	1562 @ 800	238	265	288	293
V-125	7½ x 7	3711	2240 @ 850	242	340	384	417	442	1820 @ 900	276	312	340	346

CLIMAX ENGINE MANUFACTURING CO. • DIVISION OF WAUKESHA MOTOR COMPANY
FACTORY—CLINTON, IOWA

RUNNING TOUR with MEN in the INDUSTRY

▸ The Society of Petroleum Engineers of AIME honored 5 men at its recent Denver meeting: **Alfred H. Bell,** Illinois Geological Survey; **Raymond M. Larsen,** U.S. Geological Survey; **Lawrence W. Chasteen,** Union Oil Co. of California; and **James Terry Duce,** formerly Arabian-American Oil Company, for their work on the annual volume of oil and gas production and development statistics. Also cited was **Herbert F. Beardmore,** Gulf Oil Corporation, for his achievements as society chairman in 1946.

▸ The AOSC announced the appointment of **Jack W. Williamson** as managing editor of the *AOSC News,* which is to become an expanded bi-monthly publication in January 1961. Williamson is a former editor of the Drilling and Producing Edition of *The Petroleum Engineer.*

▸ **E. F. Carlston** has been promoted to research associate in chemicals exploratory research, Richmond Laboratory, California Research Corporation.

▸ **A. R. Ratti** has been promoted to assistant land superintendent for Continental Oil Company's southwestern region.

▸ **C. J. Livingstone** assumed the post of an associate director of research in charge of product research, development and testing at Gulf Research & Development Company. He will direct the activities of product and automotive engineering divisions.

▸ In the Humble Division, Humble Oil & Refining Company, **Dr. D. G. Walker** is now senior research chemist in the Baytown, Texas, research and development section.

▸ At Mobil Oil Company, **J. Ed McHale** has been named manager, crude oil purchases and sales division.

▸ **Dudley Tower** of the Union Oil Company of California has been elevated from executive vice president to president.

▸ Sinclair Oil & Gas Company has announced the retirement of **George V. B. Pearson** and appointment of **Robert L. Brown** as manager of the systems and procedures department. **Z. D. Grissom** becomes division exploration superintendent, Central-Tulsa; **R. R. Gahring,** district manager, Alaska; **S. K. Van Steenbergh,** division exploration superintendent, Central-Tulsa.

▸ **C. D. Mims,** vice president of production for Standard Oil Company of Texas is being transferred to the staff of vice president, exploration and production of Standard of California. **Vern L. Taylor** will assume Mims' duties in Houston.

▸ **W. J. Wooten** has been elected vice-president and manager of exploration for Texas Gas Exploration Corporation. **Monty G. Martin** was appointed manager of gas reserves and **D. E. Killam Jr.,** manager of the land department.

▸ **Horace B. Arnold** retired as division office manager of Sun Oil Company's Mid-Continent production division. He will be succeeded by **Herman G. Biederman.**

▸ **The U. S. Bureau of Mines,** formerly a four-branch unit, now consists of two branches — Petroleum Research and Petroleum Economics. Petroleum production, petroleum chemistry and refining and oil shale have been combined in the new branch of Petroleum Research. Bureau responsibilities remain unchanged.

New officers selected by the directors of the American Association of Oilwell Drilling Contractors during their 20th Annual Meeting in New Orleans are C. B. Webster, Houston, vice president for Gulf Coast; Dale Mount, secretary-treasurer, Dallas; Earle C. Hellums, National vice president, Houston; John J. Moran, president, Wichita Falls, Texas; Warren L. Baker, executive vice president, Dallas; and Joseph M. Shelton, general counsel, Dallas, Texas. Back row, also left to right, are C. H. Todd, Wichita, Kansas, vice president for Central Mid-Continent; George B. Kitchel, Houston, vice president, offshore; Paul F. Rutledge, Santa Fe, New Mexico, vice president, Rocky Mountains; M. L. Vance, Mt. Vernon, Illinois, representing John R. Burns, Evansville, Indiana, new vice president for Illinois, Indiana, Michigan and Kentucky; John S. Hagestad, Bakersfield, California, vice president, California; James H. Phillips, Jr., Fort Worth, Texas, vice president, north and west central Texas; and R. C. Tucker, Midland, Texas, vice president for New Mexico and West Texas. Not included are F. M. Stevenson, Denver, vice president for Cable Tools; J. J. Harrigan, Oklahoma City, vice president for well servicing; and J. K. Maxwell, Kilgore, Texas, vice president for Cretaceous and Tertiary Basins.

New Literature

Industrial Water Service

A 24-page brochure published by Hall Laboratories describes their industrial water consulting service. Colorful booklet discusses whole range of water problems —from pre-treatment to waste disposal— and highlights the necessity for proper water management to obtain lowest water costs. *Hall Laboratories.*

Circle number (1) on reply card.

Diesel Service Directory

A handy directory of world-wide sales, service and parts outlets for Detroit Diesel engines has been prepared by the factory.

Over 600 outlets in the United States, Canada, Mexico and overseas are listed by state, province and country. Booklet gives addresses and in most instances telephone numbers for day or night service. *Detroit Diesel Engine Division.*

Circle number (2) on reply card.

Chart Integrator

Bulletin 419 published by American Meter provides complete details on American Chart Integrator, which interprets American Strip Charts and conventional round charts.

Chart integrator provides three values from a single run. It computes chart extension for differential and static pressure, and also provides read-out values for average absolute static pressure and average differential pressure. *American Meter Company.*

Circle number (3) on reply card.

Pump Motors

Brochure consisting of a collection of technical articles on pump motors is offered by U. S. Electrical Motors.

Technical articles, written by engineering department of company, are illustrated with various charts, diagrams, graphs, tables, and cutaways dealing with subjects covered.

Topics include "What You Should Know About Turbine Pump Motor Lubricants," "Facts About Pump Motor Bearings," "Why and How of Pump Motor Protection," "Pumping Stations and Sound Control," and "Helpful Steps in Submersible Installations." *U.S. Electrical Motors.*

Circle number (4) on reply card.

Chemical Demulsifiers And Flow Inducers

Tretolite has produced two brochures, a 16-page brochure on chemical demulsifiers for producers and an 8-page brochure on flow inducers.

Chemical demulsifier brochure contains photographs, photomicrographs, charts, and other illustrations describing emulsions and demulsifiers. A schematic drawing included depicts how more than thirty factors in a normal production system may effect treating efficiency and treating costs. *Tretolite Company.*

Circle number (5) on reply card.

150 to 1250-HP Pumps

Barry Pump brochure describes pumps now being manufactured in sizes 150 to 1250 hp, with pressure capacities ranging from 500 lb to 20,000 lb in V60 quadruple plunger type. *W. R. Barry Pump Company.*

Circle number (6) on reply card.

Surface Casing

Naylor Pipe has published a bulletin on light-weight conductor surface casing for rotary-drilled wells. Illustrated folder presents technical data on both threaded and slip-joint surface casing. *Naylor Pipe Company.*

Circle number (7) on reply card.

MOST RESPECTED PACKER

It's known the world over for sheer downright dependability

BAKER RETAINER
PRODUCTION PACKER
PRODUCT 415-D

This great packer has many applications—it's as versatile as it is dependable. It's a single-string production packer that comes in many sizes and bores. Moreover, it is surrounded by a family of accessories that transform it into a dual or triple packer—or into a temporary or permanent bridge plug or squeeze tool. Its formidable pressure-holding capacity makes it in many ways one of the finest of all squeeze packers.

It is set on a wire line—or on tubing or drill pipe. Baker's fast new milling tool mills one out in two to four hours—a fourth the time it once took.

For the latest practical knowledge of how to use Baker Retainer Production Packers, call your Baker Representative.

THE DOUBTS that harass well operators got a real body blow when the now-celebrated Baker Retainer Production Packer was developed some years ago.

This is probably the most predictable (and certainly the most respected) packer ever to go into an oil well. It commands the respect and confidence of operators the world over.

WHAT'S THE SECRET of building a packer so tough and reliable you know it will keep you honest when you recommend it?

For one thing, it takes time—years of performance studies. We've sweated out failures and assessed our successes—sifted out weak points and strengthened the strong points.

This great packer is at work right now in tens of thousands of wells—the average wells, the corrosive wells, the deep, hot, high pressure wells.

THAT'S A TOUGH proving ground—one that has helped us soak up a vast knowledge of what happens to slips, packing elements, and the like, when a packer is downhole. We've got the facts.

Baker made the first retainer packer—for many years the *only* retainer-type packer. The result is a wealth of packer experience that's hard to equal.

This remarkable packer shows it. Over the years we've refined it into a tool that has unyielding stamina. That's why we can call it the most predictable packer of them all.

BAKER

RETAINER PRODUCTION PACKER

BAKER OIL TOOLS, INC. HOUSTON / LOS ANGELES / NEW YORK

Desander and Mud Mixer

Four-page, two-color brochure desander with capacities as follows: single cone, 250 gpm; two cone, 500 gpm; three cone, 750 gpm; four cone, 1000 gpm.

It also describes mud-mixer with a hopper volume of 500 lb bentonite and 1000 lb barytes which will feed from 100 to 3500 lb per hour. Pump volume is 250 gpm. *Thompson Tool Company.*

Circle number (8) on reply card.

Liquid Classifiers

Bulletin No. 2503, a revised eight-page brochure, describes rubber-lined Dorr-Clone liquid cyclone classifiers. Unit is available in 6, 12, and 24-in. diam, each furnished with a choice of several sizes for vortex finder and apex valve openings.

Description of Siphontrol underflow control has been added in revised brochure. Control, which may be supplied as an accessory, maintains underflow density automatically and without instrumentation over a full range of feed variations. *Dorr-Oliver Inc.*

Circle number (9) on reply card.

Magnetic Gage

Magnetic Gage Catalog, 6-page, two-color Catalog No. 3888, covers in detail features, models, construction data, and how ingenious Jerguson Magnetic Gages operate. These liquid level gages are designed for use where glass and its gaskets cannot be tolerated and where a sealed container for liquid is preferable. *Jerguson Gage and Valve Company.*

Circle number (10) on reply card.

JONES CONSTANT RESEARCH LENGTHENS ROD LIFE

From its beginning in 1894, Jones research has been working ahead anticipating tomorrow's sucker rod requirements. Deeper wells and heavier loads have created an ever-increasing demand for higher and higher strength rods . . . a demand that has always been satisfied by Jones advanced designs. Jones constant search for improved chemical composition and new processing techniques has provided the industry with tougher, longer-lasting sucker rods to meet every pumping requirement. Always specify Jones . . . sucker-rod specialists since 1894.

THE S. M. JONES COMPANY

Division of Buffalo Eclipse Corporation

General Office and Factory: TOLEDO, OHIO

Sales Office: Enterprise Building, TULSA, OKLAHOMA

Export Department: The S. M. Jones Company

SUCKER RODS

Pipe Connections

First complete catalog of pipe connections and accessories designed on new Grayloc seal principle has been published by Gray Tool.

Manual's 44-pages contain all new types and ratings of clamps, collar-type unions, flanges, vessel nozzles, closures, and bleeder valves. Products with related applications are also cataloged, including bimetallic pipe, fittings.

Special feature of new manual is exclusive 10-page table of allowable working pressures for pipe and connections from 1-in. to 30-in. Relative costs of 39 piping materials are also tabulated in this working manual.

Seal principle, designed to eliminate connection leakage at pressures to 40,000 psi, permits design for high resistance to thermal shock and vibration. Seal ring may be employed with a fast make-up, two-bolt clamp, a union or flange, *Gray Tool Company.*

Circle number (11) on reply card.

Slush Pumps, Pump Units

National Supply has issued literature on their three-in. stroke triplex plunger pump, slush pumps, pumping units, and beam-and-crank counterweighted pumping units.

A four-page, two-color brochure describes new J-50 three-in. stroke triplex plunger pump, which has a built-in, diaphragm-type suction dampener.

A similar folder describes H-850 and H-1250 slush pumps, which feature a dual cage fluid end arrangement for liner retention and fluid sealing.

Pumping Unit Selection Guide is designed to give up-to-date information on complete line of Pumping Units.

Selection guide for company's beam and crank counterweighted pumping units is available, also. Bulletin 518 gives tabular data on every model and combination of specifications, including a range of maximum counterweight effects from 2571 to 27,500 lb, and strokes of 16 to 120 in. *National Supply Company.*

Circle number (12) on reply card.

Welding Training Aids

Fifty helpful welding training aids are listed and described in a folder. Listing includes books on a wide variety of welding subjects, welding charts, welding educational films, welding training aids, welding codes, and welding specifications. *Hobart Welding School.*

Circle number (13) on reply card.

Apparatus and Instruments

Chandler Engineering's 20-page three-color catalog describes company's apparatus and instruments.

Illustrated and described are critical-flow prover, dead-weight testers and accessories, dew-point recorders, dew-point testers and accessories, diamond core drills, recording-gas gravitometer, gas gravity balances and accessories, hydrometer, jar and specific gravity hydrometer, LP-gas testers, mercury purifier, oil sampler, oil well cement pressure curing chamber, oil well cement thickening time tester, orifice well tester, pilot tubes, plumb bob and thermometer combinations.

Other equipment includes porosimeter, pulsameter, pycnometers, vapor pressure bombs with parts and accessories, super compressibility apparatus, and thermometers. *Chandler Engineering Company.*

Circle number (14) on reply card.

Everything depends on this man.

From the time he rolls up to your location behind the familiar field unit, the success of your operation . . . and Schlumberger's too . . . is in his hands.

But look what he has done before he got there!

The typical Schlumberger field supervisor is a graduate engineer. He has received extensive training at Schlumberger schools in the design, function, operation, maintenance, and field interpretation of more than 30 specific down-the-hole services.

It's a man-sized, 24-hour-a-day job. But you can be sure that he knows his business from the ground down . . . because Schlumberger devotes as much attention to engineer selection and training as to the development of new techniques.

You might remember this the next time he walks up. His credentials and capabilities are certified by success.

THE EYES OF THE OIL INDUSTRY

SCHLUMBERGER

your Schlumberger Engineer really knows his business

from the ground down

What's behind the demand for

CF&I Seamless Casing and Tubing?

Look at the company and what it represents. For the petroleum industry, the Image of CF&I stands for a high grade of seamless casing and tubing. The steel used is made by CF&I. Manufacturing facilities and equipment are among the most up-to-date in the industry. CF&I's production techniques feature unusually exact quality controls. For special technical problems, CF&I offers expert engineering services.

CF&I's mill is ideally situated in Pueblo, Colorado. Around it, a thousand miles in every direction, stretch the rich oil fields of North America. This location facilitates rapid delivery, either by rail or truck, even to the most remote sites. All CF&I Seamless Casing and Tubing is made to API specifications. It's available in sizes 2⅜" to 9⅝" O.D. Get full details from a CF&I Sales Representative or your local distributor.

7524

CF&I STEEL **SEAMLESS** *casing and tubing* API

THE COLORADO FUEL AND IRON CORPORATION • DENVER, COLORADO

Time Cycle Controller

Brochure describing a new fully-automatic time cycle controller has been published by Camco-King. Controller may be used for any application that requires automatically opening and closing a motor valve on a predetermined time schedule.

Features, application, operation, specifications and prices of the controller are included in the brochure. Schematic drawings show how the equipment operates with ordinary injection gas and without a clock. *Wilson Supply Company.*

Circle number (15) on reply card.

Screw Thread Standards

Screw threads of the world are collated in one volume and given a common denominator of comparison. Over 2000 standards are listed, covering 33 countries which have national standards for screw threads. There are 108 screw thread forms illustrated, together with self-tapping screws. Available at contributory price to United States at $1.50 per copy post free. *W.H.A. Robertson & Co., Ltd., Lynton Works, Bedford, England.*

Circle number (16) on reply card.

Contract Research Outline

"Procedures of Contract Research for Industry," first in a series of illustrated statements from Battelle Memorial Institute, describes in a step-by-step manner the relationship between the institute and its clients. Series attempts to more clearly define unique character of the contract research organization and procedures it employs. *Battelle Memorial Institute.*

Circle number (17) on reply card.

Material Classification

A revised Material Classification Manual has been adopted by Petroleum Accountants Society of Oklahoma. Manual will communicate depth of current account control, depth of inventories, and depth of settling inventory differences on joint interest operations. *Ross-Martin Company.*

Circle number (18) on reply card.

Core Drilling Rig Described

Acker Presidente, a new core drilling rig designed for very deep core drilling and versatile operation, is described in a new six-page illustrated folder, Bulletin 31.

New drill, available in both skid-mounted and truck-mounted models, can be used to core to depths of 4500 ft. *Soiltest, Inc.*

Circle number (19) on reply card.

Pumping, Hydraulic Data

Cost of electrical pumping, how to survey a deep well, methods for testing pumps, these are but a few of the helpful facts contained in a 20-page manual titled "Useful Pumping and Hydraulic Engineering Data."

Written with strong emphasis on practical data for the engineers everyday use, manual has many useful charts and problem-solving formulae. *Food Machinery and Chemical Corporation.*

Circle number (20) on reply card.

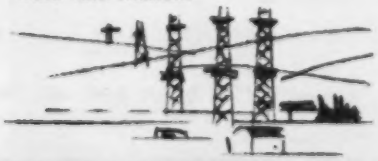
3 to 5 times LONGER SERVICE

with

RED DOG PACKING

in Polish Rod Stuffing Boxes and Slush Pumps

Extensive field tests have proven Red Dog packings provide a tighter seal for a wide range of operating requirements. Unique cross section provides highly efficient sealing of rod and bore surfaces with minimum wear and friction.

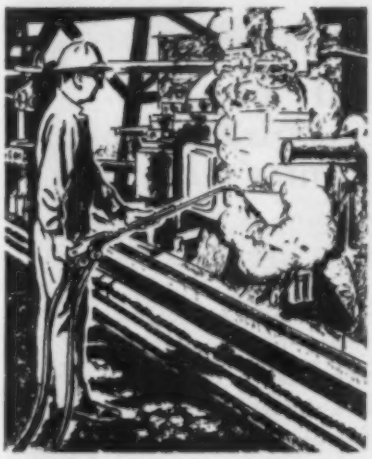


Pacific MOULDED PRODUCTS

PACIFIC MOULDED PRODUCTS CO.

905 EAST 59TH STREET • LOS ANGELES 1, CALIFORNIA

Another benefit of an Oakite ECP*



Oakite "Hurriclean"® gun speeds up tough jobs

Mechanized methods and chemical cleaning — Oakite ECP combines them both where it will save the most time, work and money.

For big drilling equipment, elevators, pumps, power units, Oakite ECP has designed an extraordinary power package. It's the "Hurriclean" Steam-Detergent Gun. With a twist of the wrist, this gun's swiveling nozzle discharges a potent combination of detergent-saturated steam plus steam heat and steam force to blast away grease, sludge, muck from hard-to-reach places.

OAKITE ECP is a detailed Engineered Cleaning Program developed to fit your particular operation under the experienced supervision of your local Oakite man. ECP covers all your cleaning needs.

For more details write Oakite Products, Inc., 47A Rector Street, New York 6, N. Y.

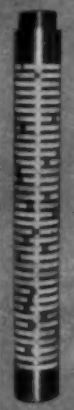
OAKITE

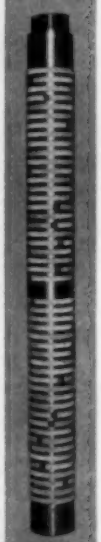
over 50 Est. 1909 years' leadership in industrial cleaning

Let R-u-b-b-e-r Take The Wear

in your sucker rod pumps

IT COSTS YOU LESS THAT WAY





● MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.

● MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.

● The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

Write for our new 1960 catalog or see it in the new Composite (24th Edition). All products sold thru supply companies.

JOHN N. MARTIN

Manufacturer

3 W. BRADY STREET • TULSA, OKLAHOMA

Drilling-Producing

NEW EQUIPMENT

Log Finds Perforations

PIP (Precision Identified Perforations) Log recently introduced by Schlumberger Well Surveying confirms the placement of shaped charge perforations with respect to productive zone. Service is offered as a supplement to Perforating Depth Control Log, and it is presently being made available on perforations performed with retrievable shaped charge perforators.

Method employs special shaped charges fired at top and bottom of perforated interval. Charges leave traces of radioactive material within perforations which are indicated by sharp peaks on gamma ray run after perforating.

This PIP Log recording is correlated with depth of control gamma ray log, which is run prior to perforation, to confirm accuracy of placement. Use of Gun-Gamma Ray enables completion of entire operation on one trip in well. *Schlumberger Well Surveying Corporation.*

Circle number (21) on reply card.

Trailerized Slush Pump

"Trailerized" slush pump unit developed by Continental-Emsco operates with trailer frame resting upon ground. Low level of operation assists in maintaining a flooded suction.

Canted trailer frame raises wheels from

ground when released from tractor truck and pump base is lowered to ground, thus eliminating need for jacks. This also dampens pump vibrations and a minimum of matting is required.

Suction hose runs under axle unit at rear of trailer.

When trailer is winched onto truck for hauling, wheels return to roading position. *Continental-Emsco Company.*

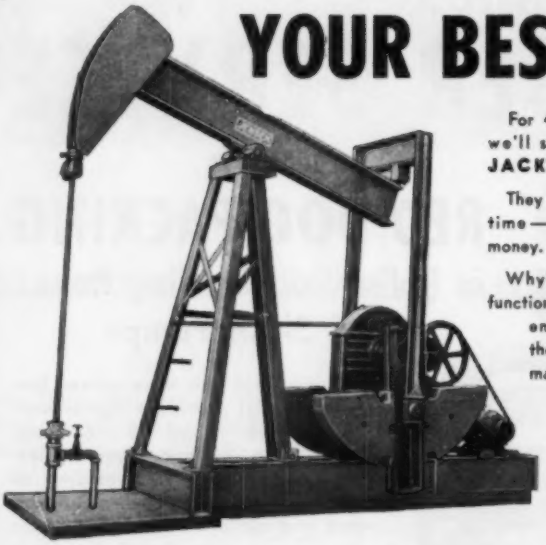
Circle number (22) on reply card.

Rotary Hose Designed For High Temperatures

Rotary hose made with improved synthetic textiles, synthetic rubber and wire reinforcement designed to withstand high temperatures encountered in deep-well drilling has been developed by Hewitt-Robins, Inc. Line is designed for high resistance to effects of drilling mud, oil emulsions, and abrasive substances.

Tube is covered with a breaker fabric and a 7-ply carcass of high-tensile fabric impregnated with rubber. Four layers of

YOUR BEST BUY!



For 40 years we've said it but we'll say it again—**JENSEN JACKS** are your best buy!

They work longer with less down time—pump more oil for less money.

Why? Because their simple, functional design is based on sound engineering principles and the use of the right modern materials in the right places.

Get the facts on **JENSENS** before you equip that next well—no matter how deep it is or where.

STOCKED BY YOUR LOCAL SUPPLY STORE

Made by **JENSEN BROS. MFG. CO., INC.,** P. O. Box 477-B, Coffeyville, Kan.
Export Office: 250 Park Avenue, New York 17, N.Y.

JENSEN JACKS

single-strand steel wire applied by a new manufacturing process reinforces body of the hose.

Each bank of wire is imbedded in a thick layer of rubber and fabric. For additional reinforcement at coupling, a 7-strand wire cable is spirally-wound for 36 in. at each end of hose. An open-weave fabric is placed between the wire and thick outer cover of neoprene-base synthetic rubber. Coupling is built flush with hose, eliminating hazard of snagging by protruding parts.

Hose will be available in three sizes, 2½-in., 3-in., and 3½ in. ID. It will be available in any length up to 60 ft. *Hewitt-Robins, Inc.*

Circle number (23) on reply card.

Threadless Pipe Fittings

New type of Green Triangle Telsco Threadless Pipe Fittings have recently been added to present line of fittings. Designated Type 600, they are manufactured from shock-resistant, high-tensile malleable iron castings and are designed to be used with regular steel, aluminum, or thinwall steel pipe.

Special modified fittings are furnished for use with plastic pipe, and fittings require no special preparation of pipe ends such as threading or grooving, and they can be installed with an ordinary pipe wrench.

Couplings are long enough to maintain an exact pipe dimension by bridging a gap caused by error in cutting or a split in pipe.

Sizes available are 2 in. and 3 in. Non-shock cold working pressures are 1000 psi for 2 in. and 750 psi for 3 in. Fittings offered are short, long and extra long couplings, 45 deg and 90 deg ells, full compression and threaded branch tees, male threaded adapters, and threaded or socket weld line couplers. *Continental-Emsco Company.*

Circle number (24) on reply card.

Regular Port Valve

Substantially smaller in overall height and width than conventional regular port valves, G-6 valve is equipped with a non-rising stem.

Valve incorporates all features of Grove's Seal-"O"-Ring design. Metal inner seat rings give a primary metal-to-metal seal backed up by O-rings, and valve requires no lubrication.

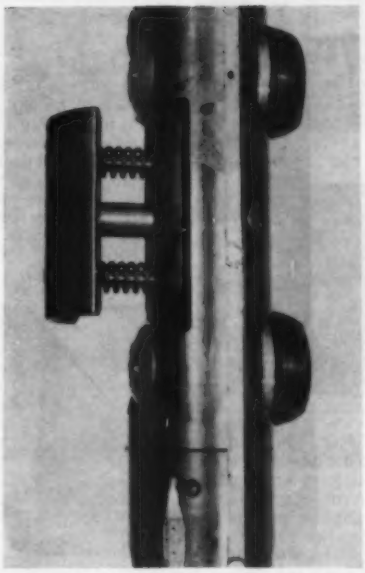
Valve is available in a 2-in. size with API 3000 lb WP and 5000 lb WP flanged, and ASA class 900 and 1500 flanged ratings. *Grove Valve and Regulator Company.*

Circle number (25) on reply card.

Two Formation Testers Designed for Cased Holes

Two wire line formation testers for cased holes have been developed by Schlumberger. One operates in 7 in. or larger casing through a single perforation, and it is an adaptation of a Schlumberger open hole tool. The other, designated Formation Interval Tester, tests through two perforations spaced 8 in. apart and operates in casings of 5½ in. and larger.

Powerful shaped charges in either tool produce perforations. Two perforations in interval tester increases flow rate into tool in low permeability formations and assure that a poor test will not result from chance penetration of a single perforation into a thin impermeable streak of formation.



Full head of mud pressure may be maintained during test, since flow from formation enters a reservoir in tool through a pressure seal forced against casing in front of perforations.

Since tests affect a portion of formation only a few inches in vertical extent, gas-oil and oil-water levels can be located accurately. Mud damage to formation is minimized because entire formation face is not exposed. *Schlumberger Well Surveying Corporation.*

Circle number (26) on reply card.

No-Wall-Stick Drill Collars

The surface area of these drill collars has been changed to reduce wall contact area by more than 40%. Weight loss of the drill collar is only about 4%. Reduction of 40% in contact area results in a proportionate decrease in the total sticking force due to differential pressure of 40%. This design also gives a section of pressure equalization each foot along the body of the drill collar.

Three sizes (6", 4¾", 4⅛") of NO-WALL-STICK DRILL COLLARS are available on a rental basis in the Texas and Louisiana Gulf Coast area. Rental price of these NO-WALL-STICK DRILL COLLARS is very competitive to conventional drill collars run with stabilizers.

Any new or used drill collars, regardless of size, owned by Drilling Contractors or Oil Companies may be converted to NO-WALL-STICK DRILL COLLARS for a fixed conversion charge.

NO-WALL-STICK DRILL COLLARS offer far more protection from wall sticking in high angle holes or holes which have shale wash outs than drill collar strings using stabilizers.

NO-WALL-STICK DRILL COLLARS will not ball up, will not peel off wall cake, and may be sealed off by a Hydril type blow out preventor at any point.

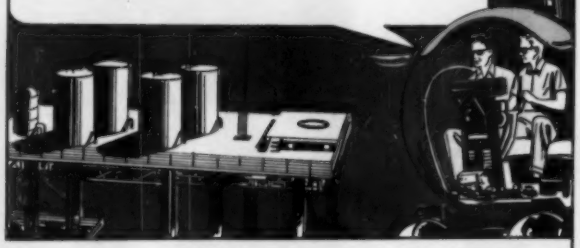
Patent Pending
ENGINEERING ENTERPRISES, INC.
HOUSTON, TEXAS
San Jacinto Bldg.
Houston, Texas
304 Kim Drive
Lafayette, Louisiana • CE 4-4607
No-Wall-Stick Drill Collars
effectively reduce sticking of drill collars
This new drill collar design has been expressly developed to combat the problem of differential pressure sticking of the drill collar string in the hole. It is a direct step in materially reducing the total sticking force.
Please write Houston office for descriptive brochure and price schedules

No-Wall Stick Drill Collars may be handled through your local rental tool company

1.

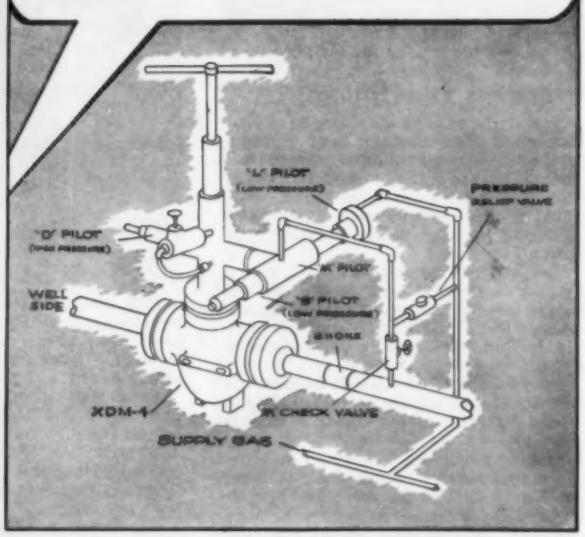
OTIS SURFACE SAFETY VALVES

—equipped with automatic pilots—shut in the six wells on this platform and PREVENTED A MAJOR FIRE that could have cost us several million dollars.



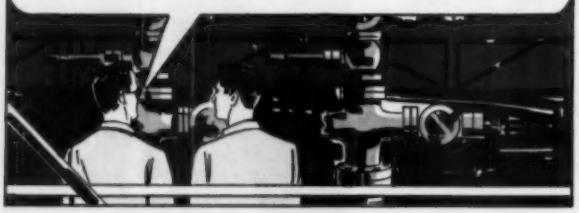
2.

Here's a diagram of the safety valve and automatic pilot installation we had on this platform. Each of the six wells had a Type XDM-4 Otis Surface Safety Valve installed between the wing valve and the choke. The safety valves and pilots were installed so as to (1) shut in an individual well should a freezing condition exist in a flow line or choke; (2) shut in all wells on the platform should a flow line break, or (3) shut in all wells on the platform should the gas sales line break, or should something happen to any of the auxiliary equipment on the platform. In this case it was high temperature on a heater that activated a Type L Otis Pilot to shut in all the wells.



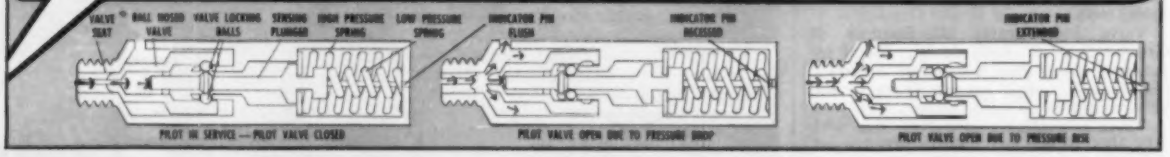
3.

The six wells were producing 32 M.M.C.F.D. when an equipment failure boosted the temperature in one of the heaters to about 1,000° F. This set the platform on fire. But we didn't lose our wells or the platform—thanks to the Otis Safety Valves. When our pumper got out here he found all of the wells shut in, and only a small fire burning, which he extinguished. After making minor repairs, the safety valves and pilots were reset and the wells put back on production.



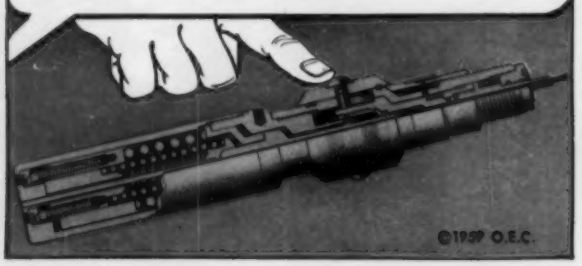
4.

Speaking of resetting pilots, have you seen the new Type E Otis Hi-Lo Pilot? It's so simple to set and reset a boy could do it. These schematic diagrams show the pilot in its three operating positions: set and ready to operate; opened as a result of a pressure drop; opened as a result of a pressure rise. The new Type E pilot has many features we like. To list a few—it's quiet. There's no loud pop when it opens. The standard model is rated to 8,000 P.S.I. and we can get higher pressure ratings on special order. The Type E is adaptable to remote control or external control systems using electricity, hydraulic pressure, or microwave. You can trip the pilot manually without any special tools. We've found the pilot accurate to plus or minus 1%. It has a visual indicator to tell you when the pilot is locked out of service, and another indicator to tell you whether the pilot operated due to a pressure rise or drop.



5.

To get back to resetting the Type E Otis Hi-Lo Pilot—here's all you do. After the pilot has operated you twist this reset collar to the right. This closes the pilot and exposes a red band, which is a visual indication that the pilot is locked out of service. When the indicator pin is flush with the end of the pilot you can put the well back on production by twisting the reset collar to the left. We'll be using a lot of these pilots in the future because of their simplicity and many advantages.



©1959 O.E.C.

6.

The Otis Surface Safety Valves and Pilots we installed on our platform only cost $6,500. That's a pretty small investment to protect a several-million-dollar installation. And this isn't the first time Otis safety equipment has saved us a substantial loss. Experience has taught us we can rely on Otis safety equipment. If you have ANY UNPROTECTED WELLS—especially in isolated locations or in critical areas—I suggest you call your nearest Otis office now. Let an Otis safety valve expert help you work up the proper safety program for your wells—TODAY—BEFORE YOU NEED IT.

Otis—"Everything's Under Control"

OTIS

OTIS ENGINEERING CORPORATION

General Offices: 6612 Denton Drive • Dallas

Branches Throughout the Oil Country

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Automatic Control Panel Regulates 5 Compressors

Multi-unit, automatic control panel has been introduced by Clark Bros. Company to serve as a single control point for operation of as many as five electric motor-driven compressors for air or gas.

Panel permits manual or fully automatic operation of any one or all compressors in group, and all control devices are electric.

In automatic position, compressors start up and shut down in accordance with a sequence set by manually-operated base unit selector. Compressors unload and shut down in a reverse sequence of starting order.

Any number of automatic shutdown devices can be tied into system to protect against malfunctions, and panel is designed to bring another compressor into operation automatically, should one that is running be shut down. Receiver pressure is indicated on panel.

Numerous auxiliary devices can be incorporated into system. *Clark Bros. Company.*

Circle number (27) on reply card.

Rotary Adjustable Flow Bean

Willis "L" Type Rotary Adjustable Flow Bean, connected to steel cross in a Christmas tree hook-up, provides adjustable flow control through flow line.

Positive indexing, allowing for increased or decreased flow, is accomplished by simply rotating orifice (choke) carrying disc 60 deg to next larger or smaller orifice position. By installing a blank insert in any one of six orifice positions, positive shut-in can be realized by revolving orifice-carrying disc to place blank orifice in line of flow while well is flowing. This eliminates need of a wing valve in hook-up and provides a simpler, more compact Christmas tree assembly.

Beans are available with either screw or flange-type connection for 1-in., 2-in., and 3-in. flow hook-ups. Orifice inserts graduate in increments of 1/64 in. and range in sizes from 1/64 in. to 74/64 in. *Willis Oil Tool Company.*

Circle number (28) on reply card.

Lost Circulation Material

A lost circulation material composed of ground and graded granular plastic, ground and graded hard nutshell, and high strength inert fibre has been developed by Cherokee Laboratories.

Designated "Poly Plug," material is now being offered only in coarse grade with maximum particle size of ¼ in. *Cherokee Laboratories, Inc.*

Circle number (29) on reply card.

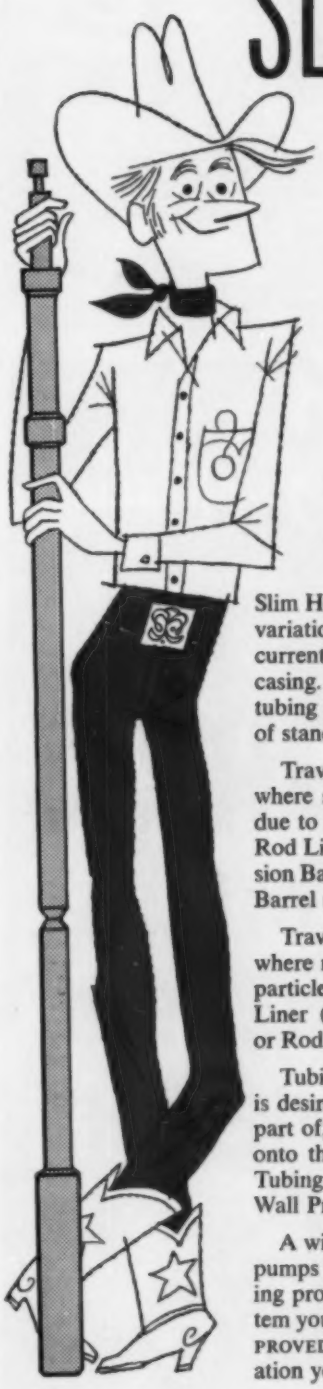
Two-Zone Pump

A new two-zone pump design recently introduced by Axelson has a long stroke for maximum production and can be installed under company's 626½-ft hydraulic pumping unit.

A single or double upper zone standing valve can be run on auxiliary tubing. Short string of tubing is easily positioned and sealed automatically. Design provides oversize standing valves for upper zone pump.

Upper zone standing valves can be retrieved without disturbing packer, main tubing string and upper and lower zone pumps by removing auxiliary tubing. *Axelson Division.*

Circle number (30) on reply card.



SLIM HOLE PUMPS

"Well-proved"

Slim Hole Completions are essentially scaled down variations of conventionally sized well bores. A current trend being the use of 2⅞" O. D. tubing as casing. A pump for these completions where small tubing is used is necessarily a scaled down version of standard A.P.I. type pumps.

Traveling Barrel Rod Pumps for installations where sand or solid particles cause pump to drag due to wedging. These pumps can be furnished as Rod Liner Traveling Barrel (R. L. T.), Rod Precision Barrel (R.W.T.) or Rod Heavy Wall Precision Barrel (R.H.T.).

Traveling Plunger Rod Pumps for installations where no difficulty is encountered by sand or solid particle. These pumps can be furnished as Rod Liner (R.L.B.), Rod Precision Barrel (R.W.B.) or Rod Heavy Wall Precision Barrel (R.H.B.).

Tubing pumps are used where maximum volume is desired. The barrel screws onto, and becomes a part of, the tubing string while the plunger screws onto the rods. These pumps can be furnished as Tubing Liner Pumps (T.L.E.) or Tubing Heavy Wall Precision Barrels (T.H.E.).

A wide variety of materials is available for these pumps to provide combinations to meet all producing problems. Regardless of the rod pumping system you should choose, installations of these WELL PROVED PUMPS will give you the trouble-free operation you desire.

WRITE FOR BULLETIN 206

DW-20

DRESSER INDUSTRIES INC.

OIL • GAS • CHEMICAL ELECTRONIC • INDUSTRIAL

PACIFIC PUMPS

Inc. . . A Division of Dresser Industries, Inc.

HUNTINGTON PARK, CALIFORNIA

Mid-Continent:
1358 So. Sheridan Ave., Tulsa 12, Oklahoma
Pacific Pumps of Canada, Ltd.,
Edmonton, Alberta

Bi-Metallic Pipe

New process which allows almost unlimited selection of materials in manufacturing bi-metallic pipe has been announced by Gray Tool. Bi-metallic pipe uses carbon steel for fabrication and strength advantages and alloy materials for corrosion resistance.

In new process, seamless lining is hydraulically expanded into base pipe, forming lining tightly against inside of base pipe material. Additional pressure expands base pipe, and on return to normal pressure, lining is firmly held against base pipe due to differential contraction.

Pipe can be butt welded, flanged and bent without damage to lining or bond between lining and base material. *Gray Tool Company.*

Circle number (31) on reply card.

Epoxy-Joined Line Pipe

Rapid, low-cost method of joining steel line pipe with an epoxy adhesive, called Series 500 Joint, has been introduced by Tex-Tube.

Technique uses a new bell-joint pipe, epoxy glue, and a simple crimping tool. Female end of each pipe length is flared to a bell shape to receive male end of another length. A special epoxy glue is applied to mating surfaces before they are joined. Patented tool crimps joint to hold it firmly together while epoxy sets. Joint reaches maximum strength in about 48 hours.

New method joins line pipe rapidly and permanently, providing a plastic-lined joint that resists internal joint corrosion. Pipe used is high-strength, lightwall pipe.

Company manufactures epoxy-joined

pipe in sizes from 1½ to 6⅝ in. Present working pressures are 1200 psi for pipe from 1½ through 3½ in. and 800 psi for larger pipe. *Tex-Tube, Inc.*

Circle number (32) on reply card.

Hard-Banding Tool Joints

Tungsten inert gas-shielded method for hard-banding tool joints and drill collars in the field has been introduced in the Gulf Coast area by Hunt Tool. Fully automatic equipment is used in applying tungsten carbide particles to oil field tubular goods.

None of the carbides is destroyed in this process, since in a gas-shielded atmosphere they are introduced into a molten pool of metal behind the arc stream and temperature of this pool is not high enough to melt particles.

Drill collars and tool joints may be hardfaced in same machine. *Hunt Tool Company.*

Circle number (33) on reply card.

Horizontal Triplex Pump

Rated at 50-input hp, National Supply has developed a plunger-type pump designed for many applications, water flooding, salt water disposal, and pumping oil.

Pump will be available in three models, J-50 L and J-50 M for low and medium pressures in corrosive and noncorrosive service, and J-50 PO for oil pumping service.

Pump has an integral suction pulsation dampener which extends full length of fluid end below and close to suction valves for maximum efficiency. An exceptionally high maximum volume of 4720 bbl per day at 560 psi is provided by this 3-in. stroke pump. *National Supply Company.*

Circle number (34) on reply card.

Multi-Control Time Switch

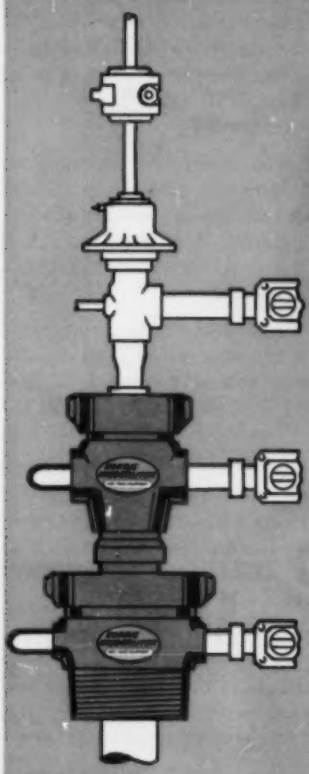
Multi-control time switch for pumping control in oil fields developed by Tork Time Controls, Inc. permits different groups of wells to pump each day with individual programs for each group.

Designated the Model 96H8001, the time switch dial revolves once in a 96-hr period. Schedules are set with tabs affixed to the face of the dial, and setting may be done with gloved or oily hands. Programs may be scheduled in any variation of one-hour increments, with 96 tabs permitting on-off settings.

Units are available in special outdoor housings or with bracket alone for panel mounting. *Tork Time Controls, Inc.*

Circle number (35) on reply card.

Engineered Simplicity



NORRIS
HINDERLITER
WELL HEAD
EQUIPMENT

Write for Well Head Equipment Bulletin for complete information.

W. C. NORRIS, MANUFACTURER
DIVISION OF DOVER CORPORATION
P. O. BOX 1739 • TULSA, OKLAHOMA
BRANCHES: Great Bend, Kansas; Corpus Christi, Houston, Kilgore, Odessa, Wichita Falls, Texas; Oklahoma City, Oklahoma; Salem, Illinois; Casper, Wyoming; Farmington, New Mexico; Edmonton, Alberta, Canada.

NORRIS HINDERLITER WELL HEAD EQUIPMENT

Buy From Your NORRIS Distributor

Compact Ball Valve

Unique ball valve developed by Cameron Iron Works requires no lubrication to seal bubble-tight, is compact and lightweight. Valve may be installed in any position without regard to top or bottom, for service even with highly abrasive or corrosive fluids. All types of electric, pneumatic, and hydraulic operators may be used with it.

Two-seat construction seals both upstream and down, permitting line to be blocked in both directions and body of valve bled off.

Each operation of valve partially rotates seat. This action changes relation of mating surfaces and gains a continuous reseating, allowing working parts to be sealed into valve for life.

Made of forged and welded construction, ball valve is made in sizes from 2 in. to 36 in. for 150 through 600-lb ASA classes and in 2 in. through 6 in. for API 1000-psi to 5000-psi working pressure rating. *Cameron Iron Works, Inc.*

Circle number (36) on reply card.

Gas Desulfurizing Unit

Automatic gas desulfurizing unit of amine-type removes hydrogen sulfide and carbon dioxide from gas by absorbing acid gases in a solution of monoethanolamine in water. Resulting sour amine solution is regenerated for re-use. The plant is in two assemblies, absorber and regenerator. *Maloney-Crawford Tank & Manufacturing Company.*

Circle number (37) on reply card.

NOW... A Complete line of

BrakeSol®

OIL FIELD CHEMICALS

Developed exclusively for solving particular problems in the petroleum industry.

P.T.C.... The original Paraffin Treating Chemical. Holds paraffin in suspension from formation to refinery.

DEMULSIFIER D-7 ... Universal Treating Compound. Gives cleaner oil with less heat resulting in a BETTER PRICE.

STIM FORM®... Clean Well Bore! Designed to remove restrictions in perforations... face of pay ... formations.

CORROSION INHIBITOR CI-123 ... Designed especially for control of oil field corrosion problems.

GYP and SCALE TREATMENT GS-20 ... Effective on these types of carbonates and sulphates: calcium, strontium, barium and magnesium.

FOR INFORMATION... Contact Supply Store Brakesol Treating Engineer or write direct!

BrakeSol INC.
REG. U. S. PAT. OFF.

P.O. BOX 9506 • OKLAHOMA CITY, OKLA.
EXPORT DISTRIBUTOR: THE NATIONAL SUPPLY CO., EXPORT DIVISION

Over 1100 field installations ... less than 2% maintenance!

OIL WELL M&T SERVICE

FRICTIONAL TUBING ANCHOR

U.S. Patent No. 2,874,783

- Smooth gripping members hydraulically actuated
- No slips to replace
- Completely automatic
- Calibrated holding power
- No bleeder valve required
- Large by-pass area
- O-ring fluid seal
- Simple construction, minimum maintenance
- Installed above pump; automatically "sets," holding tubing in natural tension
- No drag on casing going in hole or coming out unless tubing is pulled "wet"
- Can safely be installed in perforated pipe

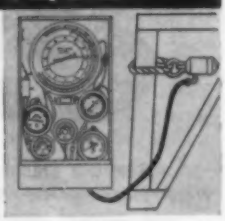
Compensates both up and down

Complete range of sizes for 4½" to 11¾" API Casing. Write for complete information.

McGAFFEY-TAYLOR CORP.
2877 Cherry Ave., Long Beach, California

TONG TORQUE

THE MARTIN-DECKER TONG TORQUE ASSEMBLY FOR ALL CONNECTIONS

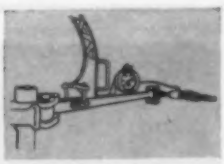


PERMANENT INSTALLATION The cylinder attached to the back-up line provides torque indication each time collars are run.

ONE GAUGE for torque measurements of all size drill collars, drill pipe, tubing and casing.

ACCURATE AND RELIABLE readings with calibration checks seldom required.

CARE AND MAINTENANCE can be capably done by the drilling crews.



PORTABLE INSTALLATION The torque assembly attached to the tong itself can be used for spot checks on two or more rigs.

MARTIN DECKER

WRITE FOR DESCRIPTIVE LITERATURE
MARTIN-DECKER CORPORATION
3431 CHERRY AVENUE, LONG BEACH 7, CALIF.

World's principal manufacturer of Oil Well Drilling Instrumentation

Oilfield Pumping Unit

Use of a new type of oil seal has made possible sealed-in-oil lubrication of wrist-pin bearings on pumping units, in place of former grease-gun lubricants that required frequent field servicing. New design is said to require no maintenance attention for life of lubricant.

Developed by Parkersburg, new seal will be guaranteed for 200,000 operating hours of service on company's pumping units.

Seal has two hardened ferrous-metal sealing rings that maintain oil-tight, self-adjusting-for-wear contact under constant pressure from two specially compounded oil-heat-cold-resistant rubber "O" rings. It can be reused and removed or installed without special tools of any kind. *Parkersburg Rig & Reel Company.*

Circle number (38) on reply card.

Slush Pump Packing

Unique outside liner packing made of hard, rigid non-extrusion material with a soft synthetic rubber core in center of ring has been developed by Universal Packing and Gasket. Feature allows Style 765 ring to bridge gaps up to ⅛ in. that might be in pump due to clearances or worn stuffing box fittings.

One set of seal rings, enough for one liner, consists of two sealing rings and a metal lantern ring. Seal rings are interchangeable with manufacturer's seal rings in that they are useable with either Universal metal lantern ring or pump manufacturer's metal lantern ring. *Universal Packing and Gasket Company.*

Circle number (39) on reply card.

SECONDARY RECOVERY

PETROLEUM ENGINEERS
STEPHENS ENGINEERING
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
Water Flooding Gas Repressuring
EVALUATION CORE ANALYSIS
SURVEYS ECONOMICS
Cost Estimates, Design, Installation
FIELD SUPERVISION
Phone 723-2167

Pressure Control Pilot

A new type of "PC" Pressure Control Pilot is now available for use in conjunction with diaphragm motor valves for on-off flow and pressure control applications.

Assembly contains a bourdon-tube actuated, non-bleed, snap-acting pilot valve which may be adjusted to open or close a motor valve at a predetermined increase or decrease in pressure.

Pilot and case is of anodized, corrosion-resistant, all aluminum and stainless steel construction. The assembly may be top-mounted on a motor valve or panel mounted. The setting of the bourdon tube pressure-control point may be easily adjusted in the field to any desired point within ½ of 1% of the bourdon tube range by simple fingertip turning of the pilot turnbuckle. *Macco Oil Tool Company, Inc.*

Circle number (40) on reply card.

Strip Chart Recorder

A new Strip Chart Recorder that provides a record of flow, pressure and temperature measurements for periods up to 36 days without attention has just been introduced by American Meter.

Instrument is cartridge type and makes possible reduced chart-changing costs. Each cartridge, including chart, storage spool and rewind spool, is removed as a unit, so that chart changes can be made in a few seconds. Cartridge will fit into American's Chart Integrator for fast interpretation.

With a chart capacity of 38 ft, speeds are available from ½ to 6 in. per hr, powered by either an electric drive or an American Gasclok Power Drive. *American Meter Company.*

Circle number (158) on reply card.

Pneumatic Controls Operate Engine Systems

First non-electric, self-powered engine safety control system that protects engine installations against dangerous overspeed, temperature, and pressure conditions has been developed by California Controls.

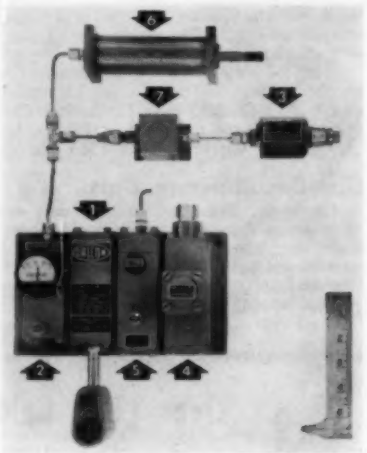
Operated through a small captive charge of compressed air, system can put into operation almost any type of pilot-operated valve, switch, warning or other device when captive air charge is dumped to atmosphere by sensing units.

Standard components are combined in a modular system and standard components are combined to meet requirements of each type installation. Equipment required for a typical engine installation includes hand-charging unit, pressure-sensing unit with charge air gage, coolant temperature sensing unit, overspeed sensing unit, lube oil pressure sensing unit, and actuating unit. *California Controls Company.*

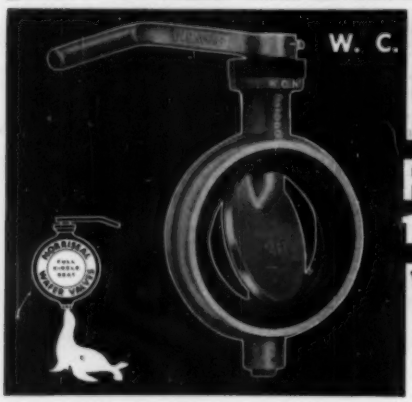
Circle number (159) on reply card.

Non-Electric System For Engine Protection

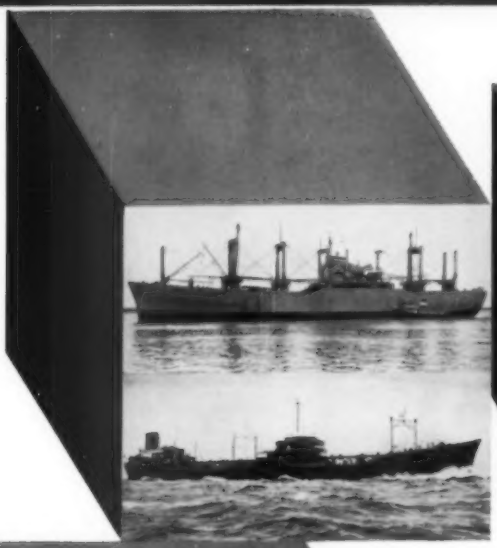
A small captive charge of compressed air operates the first non-electric, self-powered engine safety control system that protects all types of engine installations against dangerous overspeed, temperature and pressure conditions. The "Calcon" control can put into operation almost any type of pilot-operated valve, switch, warning, or other device when the captive air charge is dumped to atmosphere by sensing units. The system is of modular design, combining standard components to meet requirements of individual installation. Units in the model 490 kit required for a typical engine installation include: (1) hand charging; (2) pressure sensing with charge air gage; (3) coolant temperature sensing; (4) overspeed sensing; (5) lube oil pressure sensing; and (6) actuating. Lube oil and overspeed sensing units have built-in trouble indicators, while temperature unit has an auxiliary indicator (7). Standard copper tubing connects all parts. *California Controls Co.*

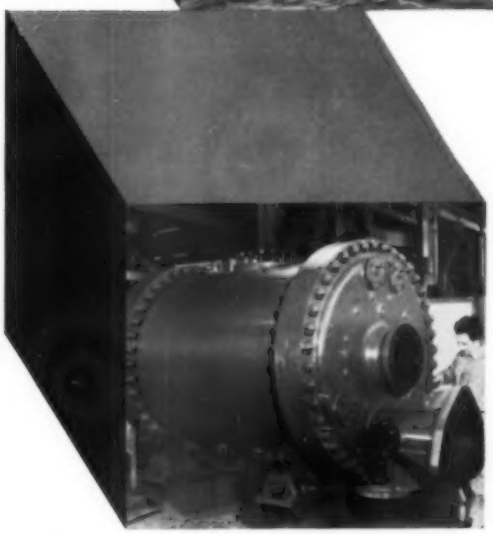


Circle number (160) on reply card.



NORRIS
Field Tested and Approved
150 psi working pressure
WRITE FOR NEW VALVE BULLETIN
P. O. Box 1739, Tulsa
VALVES





SUN SHIP
built 'em all....

Our reputation as "master builders for land and sea" is based on 44 years' service to the oil-refining, chemical and other industries.

Frequently we are called upon to produce components for the building of large plants. Our manufacturing and fabricating skills, our understanding of industry's problems are reflected in the variety of equipment we build, like the fractionating towers and special pressure vessel shown here.

In our complete, modern shops we build and *deliver* what's needed in many fields. Our special Alloy Products Shop, for example, is equipped to produce medium and heavy stainless alloy and aluminum products for industry.

Building for land • Pressure vessels • Fractionating towers • Stills and tanks • Condensers and similar equipment • Special machinery • Plate work, etc.

Building for sea • Dry cargo ships • Tankers • Marine repairs • Dredges • Ferries • Marine engines • Marine machinery.

Sun Ship does a big job for many companies, and can do the same for you.

Sun

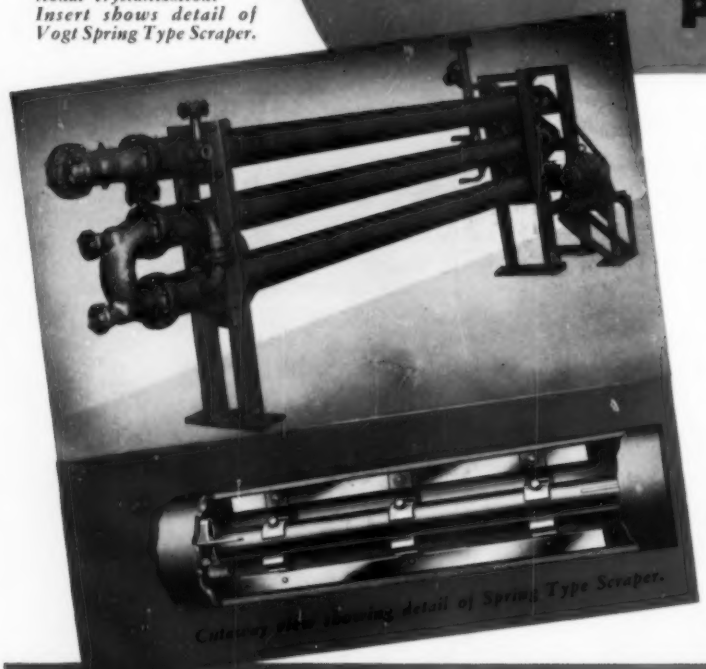
SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • SINCE 1916 • CHESTER, PA.

Vogt

SCRAPED SURFACE EXCHANGERS *Solve* those Special Heat Transfer and Crystallization Problems . . .

BELOW: *A scraped surface unit for production of Para-Xylene by fractional crystallization. Insert shows detail of Vogt Spring Type Scraper.*



Cutaway view showing detail of Spring Type Scraper.

. . . *And Here's How:*

1. Rotating scraper action continuously sweeps surfaces clean even while processing highly adhesive materials.
2. Uniform rate of heat transfer keeps crystallization under control and discharges crystals as a slurry.
3. Product is thoroughly mixed by scraper blades as it flows.
4. Closed, pressure-type system permits use of flammable, volatile and expensive solvents with complete safety and no solvent loss.
5. Units fabricated from a broad range of materials to suit process stream characteristics.

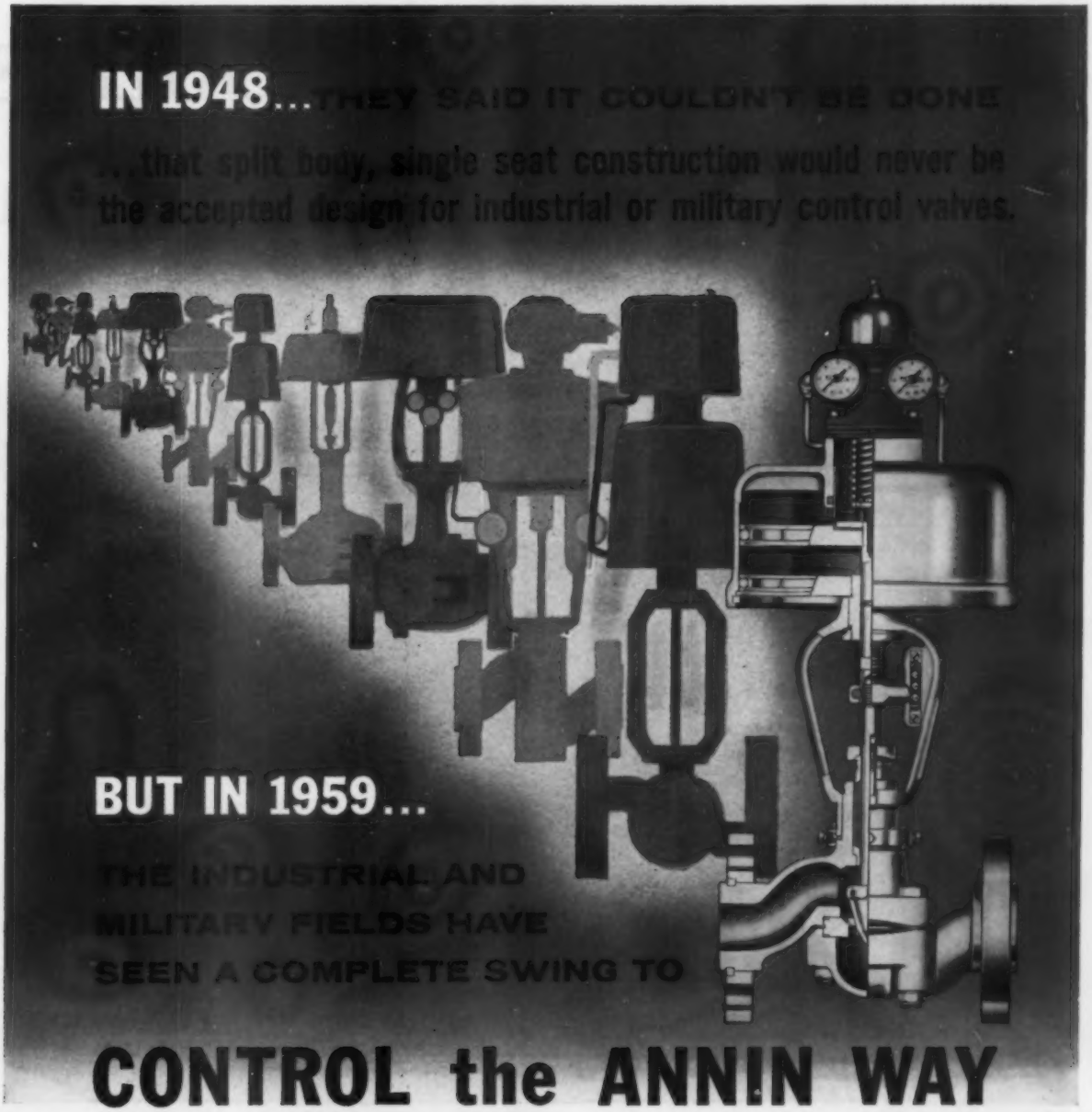
Write for Literature. Address Dept. 24A-XPE

Listed here is a wide variety of materials which have been successfully processed with Vogt Scraped Surface Exchangers in the chemical, petro-chemical, petroleum and related industries.

- Benzene Hexachloride
- Caustic Soda
- Caustic Potash
- Clay
- Cylinder Stock
- Para-Dichlorbenzene
- Fatty Acid Solutions
- Fish Oil
- Linseed Oil
- Naphthalene
- Paratone & Solids
- Phenolic Resins
- Polyester Liquid
- Pressed Distillate
- Reduced Petroleum
- Waxy Oil-Solvent Mix
- Soybean Oil
- Sperm Oil
- Sugar Syrup
- Sulfur-Oil Mix
- Sulphate Solution
- Tall Oil-Naphtha-Sulfuric Acid Solutions
- Tetrachloro Benzene
- Viscose
- Wax Slurry
- Para-Xylene

HENRY VOGT MACHINE CO.
Louisville 10, Ky.

SALES OFFICES:
New York, Chicago, Cleveland, Dallas, Camden, N.J., St. Louis, Charleston, W.Va., Cincinnati


IN 1948...THEY SAID IT COULDN'T BE DONE
...that split body, single seat construction would never be the accepted design for industrial or military control valves.
BUT IN 1959...
THE INDUSTRIAL AND MILITARY FIELDS HAVE SEEN A COMPLETE SWING TO
CONTROL the ANNIN WAY

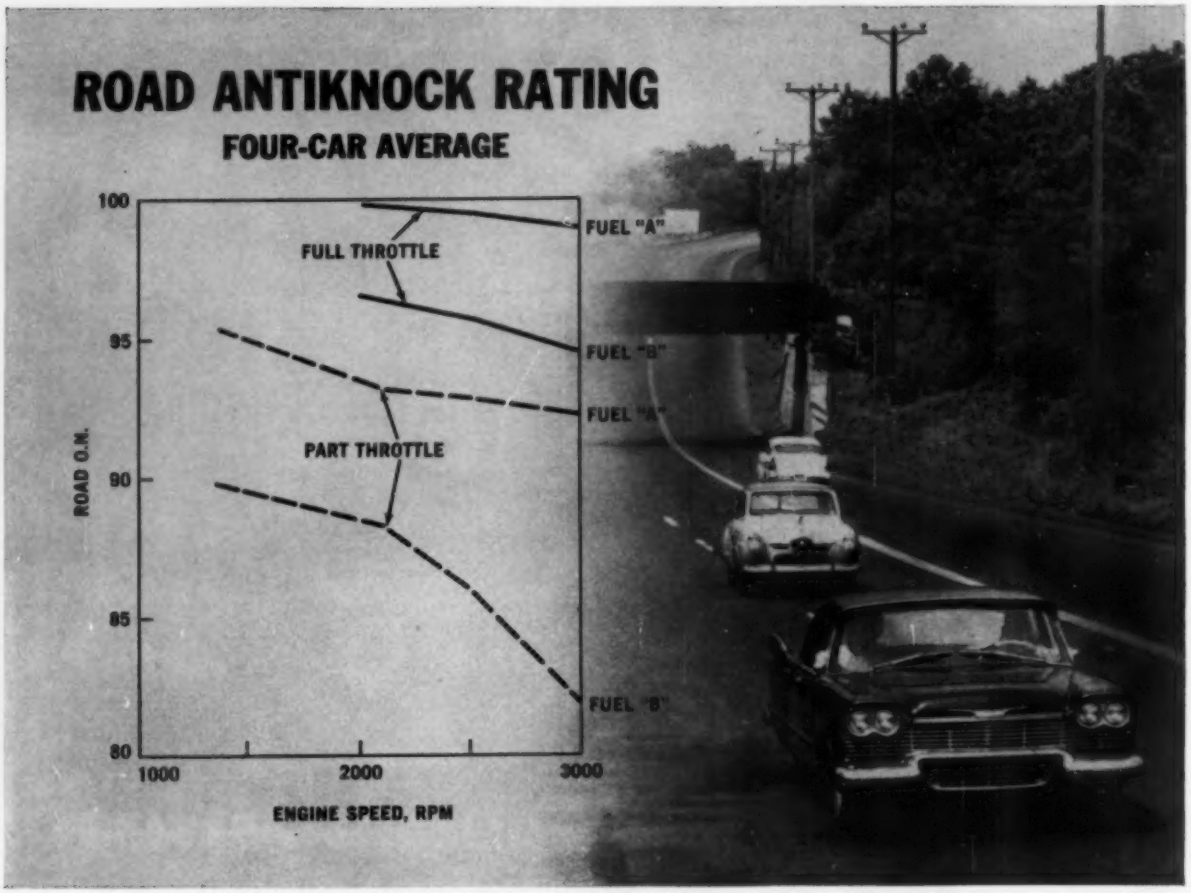
In 1948 split body construction and powerful high speed, precise positioning pneumatic piston actuators were available from only one source—Annin. Today, more than a decade of accumulated experience in this type of valve design makes Annin features and performance records the best in the valve industry. Contrary to published statements by critics ten years ago, Annin-type construction is now available from many sources. But when tempted to consider *mere-replicas* of Annin valves, remember this—they might give you a few Annin features, but when you specify Annin Valves you get them all!

Annin VALVES

THE ANNIN COMPANY
1040 South Vail Avenue
Montebello, California

There's a Road Bonus

your best buy for



Your customers—passenger car drivers—are the final judges of the antiknock quality of gasoline, by its performance in their cars on the road.

Designing a fuel to a given Research octane number specification by using a higher antiknock compound concentration will result in a road octane bonus which can pay off in terms of customer satisfaction. This is particularly significant when guarding against high-speed or part-throttle knocking problems.

That's why the road bonus that you get from antiknocks—the extra octane, over and above Research and Motor ratings—is so important.

TEL Road Bonus Demonstrated

Road bonus from antiknocks has been demonstrated by tests performed on two fuels of the same hydrocarbon-type composition, and similar distillation ranges and sulphur content. Specific aromatics, olefins and saturates were selected carefully for each blend so that both had the same nominal laboratory octane ratings.

The only difference between the two fuels was

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

from Antiknocks...

road performance

in TEL content: Fuel A contained 3.0 ml TEL/gal and Fuel B contained no TEL.

Demonstration Fuels

	A	B
Res. O.N.	98	98
Motor O.N.	88	88
% Aromatics	40	40
% Olefins	5	5
% Saturates	55	55
TEL ml/gal	3.0	0.0

Because the beneficial effects of TEL vary with car make and speed, results were based on a four-car average of current models. Test results—charted on the facing page to the left—rated Fuel A (with TEL) from three to five Road octane numbers higher than Fuel B (without TEL). Although not shown in the chart, the increase in road performance is naturally greatest with the addition of the first ml/gal, but—at the other end of the scale—the road bonus continues to go up with the use of a fourth ml/gal.

What This Means to Refiners

As you can see from the chart, the effect of TEL is greatest at high speeds, generally the critical point with modern vehicles and sensitive fuels. Part-throttle operation with certain vehicles also is critical and here the TEL bonus again is significant.

Because of this road bonus, the use of higher concentrations of antiknocks is generally the most economical means of purchasing road performance on a ¢/Road octane barrel basis.

What About the Future?

There are a number of antiknocks and "extenders" now in the development stage. Most of them promise extra quality on the road. Additive octanes from combinations of antiknocks may soon be allocated to various gasoline grades to optimize the road bonus effect at lowest cost.

For additional data on Road octane bonus from TEL, ask your Ethyl Representative for a copy of the SAE paper, "Are Octane Numbers and Hydrocarbon Type Enough?" He will be glad to see that you get one.

REMINDERS TO REFINERS

Antiknocks are your best octane improvement buy, whether costs are figured on Research, Motor or Road ratings.

Antiknocks give you a Road octane bonus you can't get any other way.

Gasoline sensitivity can be decreased with antiknocks.

Refining flexibility can be increased with antiknocks.

Antiknocks also can reduce or delay capital investment in octane improvement equipment.

ETHYL ANTIKNOCK COMPOUND — ETHYL CORPORATION

ETHYL CORPORATION, NEW YORK 17, N. Y. • TULSA • CHICAGO • LOS ANGELES

ETHYL CORPORATION OF CANADA LIMITED, TORONTO • **ETHYL USA (EXPORT)** NEW YORK 17, N. Y.

INTEGRATED PERFORMANCE ...BUILT IN!

On your next contract for construction of a new or expanded process facility, what will you expect in return for the dollars you invest?

For a better-than-average return you can depend on Procon. For Procon gives you this important extra:

From start to finish . . . through estimating, engineering, purchasing, construction, inspection . . . Procon personnel keep an eye on the big objective. Not only must each part of the job be built for perfect performance, but it must also function superbly with every other part. All must work together as a well-knit, fully integrated unit.

Only thus can you be assured of what you really want . . . a completed plant that gives you *maximum production with minimum overhead.*

PROCON INCORPORATED
1111 MT. PROSPECT ROAD,
DES PLAINES, ILLINOIS, U. S. A.

PROCON INTERNATIONAL S. A.,
CHICAGO, ILL., U. S. A.

PROCON (CANADA) LIMITED,
TORONTO, CANADA

PROCON (GREAT BRITAIN) LIMITED,
LONDON, ENGLAND

PROCON PTY. LIMITED,
SYDNEY, AUSTRALIA

PROCOFRANCE S. A. R. L.,
PARIS, FRANCE

PROCON LIMITADA,
SAO PAULO, BRAZIL

VICAPROCON, S. A.,
CARACAS, VENEZUELA

PROCON

PROCON *Incorporated*

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL AND CHEMICAL INDUSTRIES

Now Waste "Disposal" Cuts Fuel Costs In This Sohio Boiler

Firing low Btu carbon-monoxide gases—once disposed of as unusable waste—in this B&W CO® Boiler cuts fuel costs for Sohio's Toledo refinery. Using refinery gas and CO gas together, the boiler will provide up to 450,000 lb of steam hourly meeting 100% of the refinery's steam requirements. Steam conditions are 625 psi and 750 F.

This is the B&W CO Boiler, currently serving the nation's refineries by economically converting waste CO gases into working Btu's. This *boiler is specifically engineered for this task.* Fuel economies afforded by this unit, assure rapid pay-off periods and years of additional cost-saving operation.

When *you* are ready to cut refinery costs with a carbon monoxide boiler, get the facts on the one boiler designed specifically for the job—the B&W *CO* Boiler. B&W CO Bulletin G-87 covers the subject in detail. Write for your copy today. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

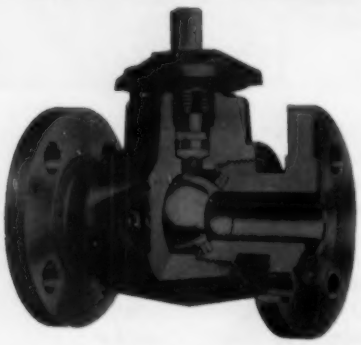
CO-109

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

LEAKPROOF AFTER 600,000 CYCLES!



Proved in the laboratory, and in over five years of field service with such difficult ladings as acetone, propane, vinyl chloride, and lime and soda-ash slurry, W-K-M's ACF Ball Valve has earned a reputation for extra long life *without lubrication.* For example —

In one test, W-K-M opened and closed a 2″ standard production model under pressure 600,000 times. The valve still sealed tight, and there was no measurable wear on either the chrome-plated ball or the Teflon seats!

W-K-M's rugged ACF Ball Valves are available in carbon steel to ASA 300 lbs. (some sizes 600 lbs.), and in semi-steel, ASA 200 and 400 lbs. WOG.

Write for Catalog 1000.

Conduit is full-bore; Teflon stem gaskets and seats are sealed from the lading flow.

WHEN SO MUCH DEPENDS ON A VALVE . . . SPECIFY ACF BALL VALVES

W-K-M

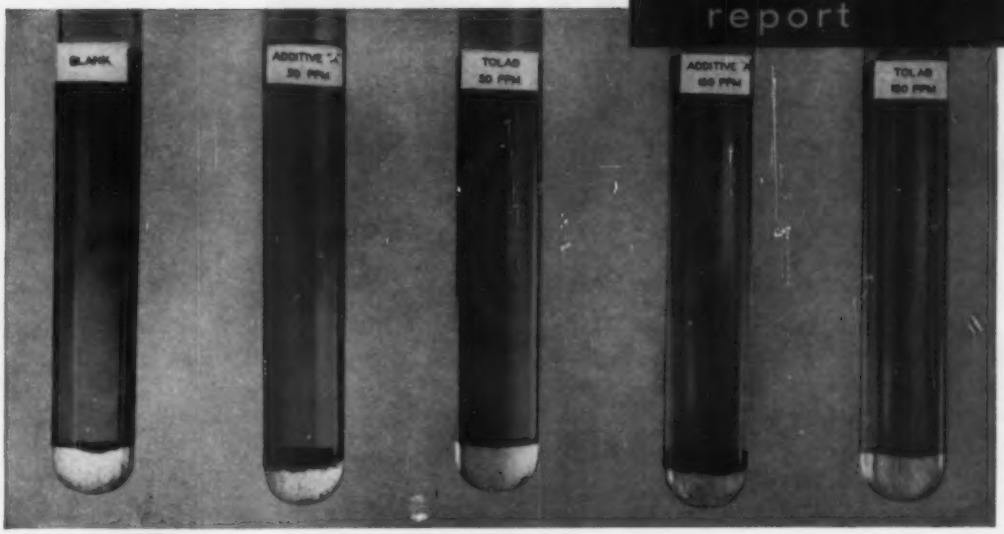
DIVISION OF ACF INDUSTRIES INCORPORATED

P. O. BOX 2117, HOUSTON, TEXAS

6006

another

TRETOLITE SERVICE report



TOLAD* *Fuel Additive maintains maximum water tolerance*

Compare the quantities of sludge in the test tubes. The TOLAD-treated fuel samples show much less sludge than the samples treated with a well-known competitive additive.

In the Tretolite Company research laboratories TOLAD Fuel Additives are continually compared with other commercial fuel additives. In test after test, fuels treated with TOLAD have had superior water tolerance.

WHY IS WATER TOLERANCE IMPORTANT?

When agitated, No. 2 fuel oils and diesel fuels form sludge if they contain water and insoluble residue. Some additives actually impair water tolerance.

HOW DO FUEL ADDITIVES AFFECT WATER TOLERANCE?

Additives which are primarily dispersants allow insoluble residue to form freely, but disperse it throughout the fuel. However, they also disperse any water which the fuel may contain, thus promoting emulsification, and eventually, sludge formation.

WHY DO TOLAD ADDITIVES MAINTAIN MAXIMUM WATER TOLERANCE?

TOLAD additives are primarily *inhibitors*. The normal water tolerance of the fuel is not impaired, and the residue problem is corrected by inhibition, rather than dispersion.

The use of TOLAD additives enhances marketability, and practically eliminates burner-tip fouling and filter plugging. In diesel fuel injection systems, TOLAD treatment prevents fouling, increases nozzle life.

In commercial application, TOLAD *has provided these advantages at costs under those of the additives it replaced.*

For information on TOLAD, or test arrangements for your fuel, write or call . . .

FA-60-8

*Registered trademark of Petrolite Corporation

PETROLITE CORPORATION

SUBSIDIARY AND AFFILIATED COMPANIES

CANADA, Edmonton, Alberta • ENGLAND, London
GERMANY, Frankfurt, a. M. • VENEZUELA, Caracas

TRETOLITE COMPANY
DIVISIONS
369 Marshall Avenue, Saint Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

REPRESENTATIVES

ARGENTINA, Buenos Aires • BRAZIL, Rio de Janeiro • COLOMBIA, Bogota
ITALY, Rome • JAPAN, Tokyo • KUWAIT, Kuwait • MEXICO, Mexico, D. F.
NETHERLANDS, The Hague • PERU, Talara • TRINIDAD, Port of Spain

DE LAVAL

CENTRIFUGAL COMPRESSORS

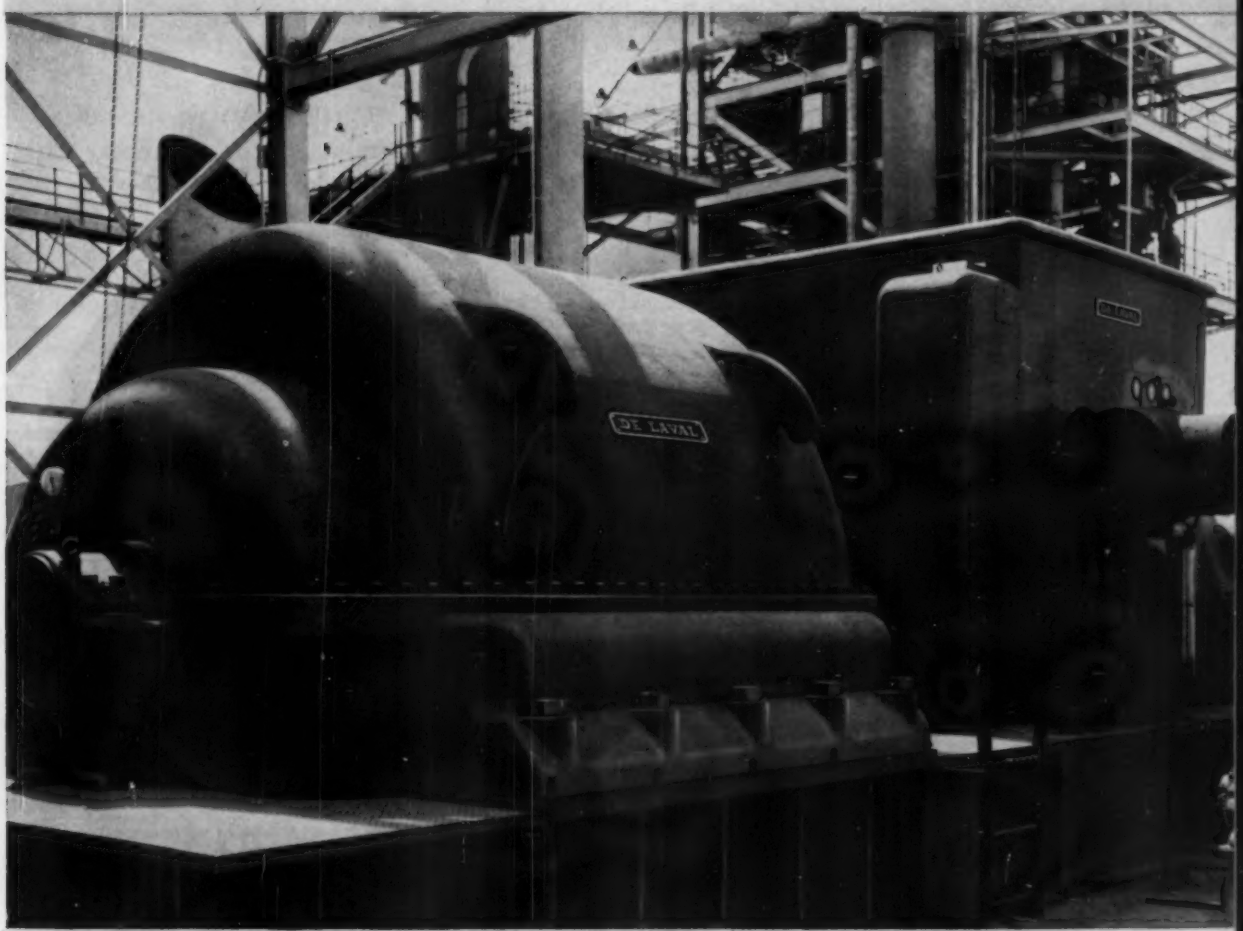
11,300

Driven by automatic extraction steam turbine

Shown below is the large 11,300 horsepower centrifugal blower which compresses air for the main blower service in catalyst regeneration at Standard Oil of Ohio's new refinery at Toledo, Ohio.

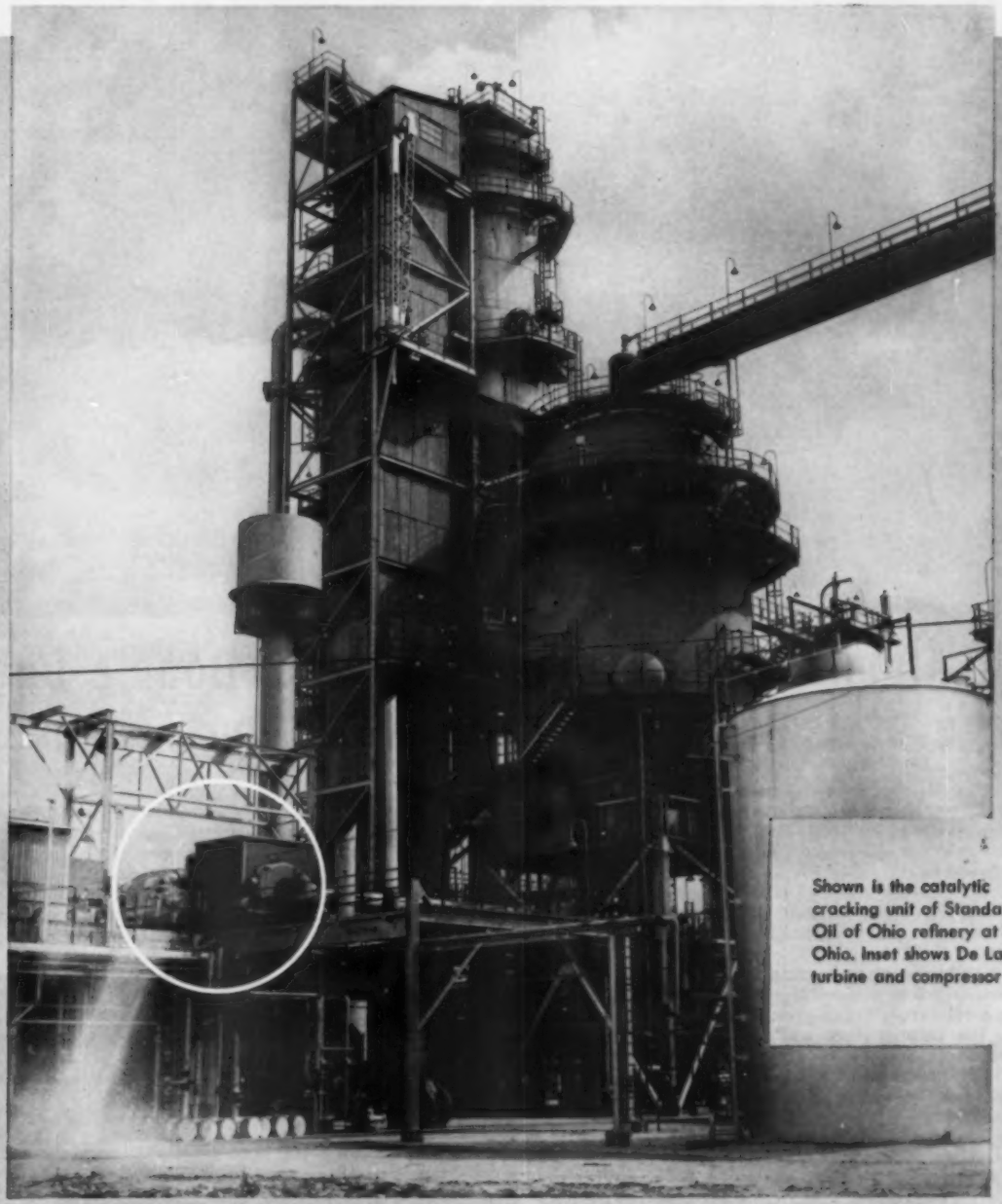
Driven by a De Laval single automatic extraction steam turbine, it compresses 110,300 cfm in four stages at 2800 rpm. Inlet pressure is 14.7 psia and discharge pressure is 40.7 psia. The turbine is designed for 600 psig ISP, 740F extracting at 55 psig, and exhausting to 28″ Hg.

This is another example of De Laval proved performance.



DL-487

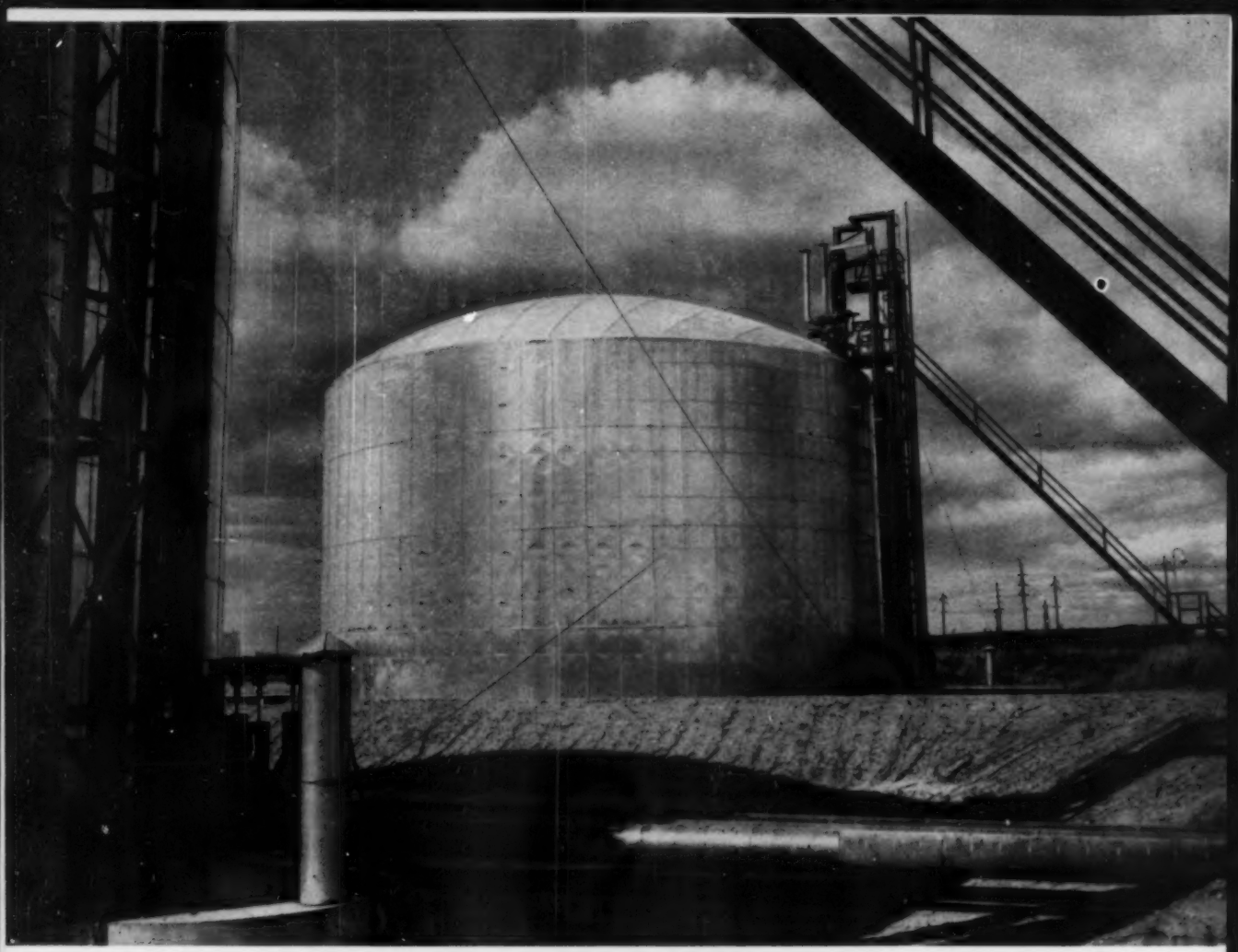
horsepower DE LAVAL compressor for "cat cracker" at SOHIO refinery



Shown is the catalytic cracking unit of Standard Oil of Ohio refinery at Toledo, Ohio. Inset shows De Laval turbine and compressor unit.

DE LAVAL *Steam Turbine Company*

920 NOTTINGHAM WAY, TRENTON 2, N. J.



Novel Aluminum-Insulated Tanks for Double-Duty Storage of Liquid Butane and Anhydrous Ammonia

The science of cryogenics is no more profitably applied than at St. Paul Ammonia Products, Inc., Pine Bend, Minn., where two 45,000 bbl. low-pressure, refrigerated steel tanks with multiwall aluminum insulation were recently placed in dual-service.

During the summer and fall, liquefied butane is stored at +25°F. During the winter and spring, anhydrous ammonia is stored at —18°F. The design pressure, in both instances, is 5 psig.

Thus, in summer when butane is more readily available, the two tanks preserve huge quantities of potential B.t.u.'s in a relatively small area, thanks to storage as a liquid at a low temperature and pressure. The butane is used by St. Paul Ammonia as a raw material for manufacturing anhydrous ammonia, which, in turn, is stored in the tanks for the spring, when demand from fertilizer users is heaviest.

A low operating cost is achieved by a completely automatic system of filling and emptying the tanks. Outer layers of aluminum to reflect the sun's rays provide an insulation that effectively aids in maintaining the desired temperatures. Asbestos Products, Inc., St. Paul, installed this novel insulation.

Designed, fabricated and field-erected by Graver, these two tanks represent one of many types of cryogenic storage and processing equipment Graver has been called on to design and produce. The opportunities for cutting costs and improving efficiency are substantial when the science of cryogenics can be employed. If there is an application in your operation, it will pay you to talk it over with Graver.

PIONEERS IN FABRICATING FOR APPLIED CRYOGENICS

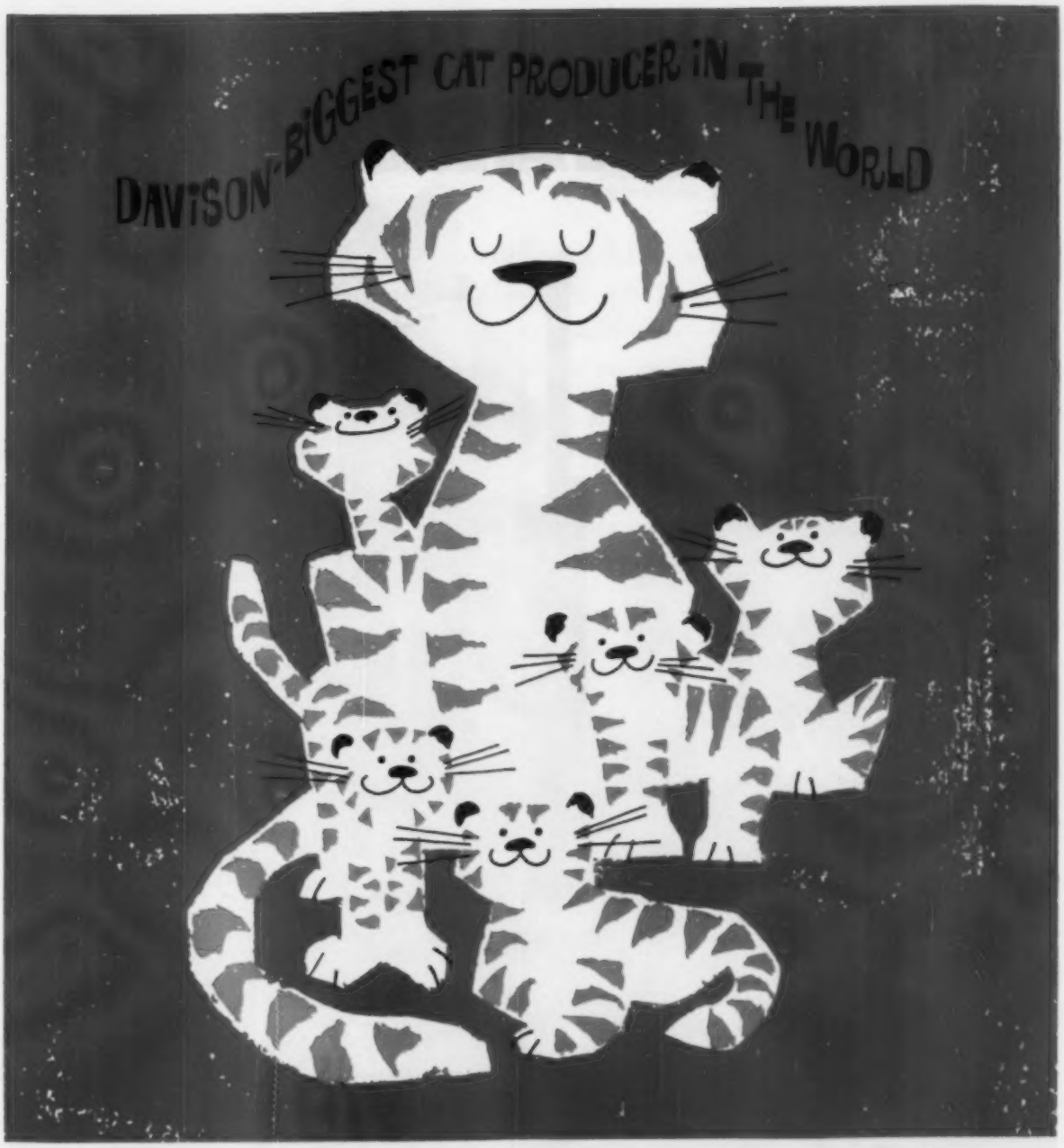
Graver

DIVISION—UNION TANK CAR COMPANY

Graver Tank & Mfg. Co.

EAST CHICAGO, INDIANA

PLANTS AND OFFICES ACROSS AMERICA



OFFERS YOU A "CATULATOR"

to make your work with cats so much easier

Here is a fast, easy way to check on calculations for carbon burning rates, hydrogen on coke, catalyst inventories and catalyst bed densities . . . and it's yours **without charge or cost.**

The "Catulator" is exclusive with Davison, developed and created by Davison experts to provide petroleum refinery men with a reliable, accurate processing aid.

This easy to read, plastic coated slide rule Catulator is available to any one who needs to calculate data involving the use of cracking catalyst. Just ask your Davison salesman.

DEPARTMENT B-11

W.R. GRACE & CO.

DAVISON CHEMICAL DIVISION

BALTIMORE 3, MARYLAND

Make shorter work of TURNAROUNDS

Every OAKITE ECP utilizes chemical cleaning for towers

Where carbon and iron oxides and sulphides must be removed: circulate Oakite 85. Combining acid and solvent cleaning properties Oakite 85 penetrates heavy scales and corrosion-type soils, tears them from equipment walls, then rinses freely and completely. It's safer than raw acids, because it's inhibited against attack on ferrous metals . . . easy on synthetic rubber. One user says:

When this 40-ft., 12-tray tower was off-stream previously, "hand" cleaning required 5 days and $3,000. Using Oakite 85 by circulation method, we did a complete job of removing fouling soils in just 32 hours . . . for only $750.

For heavy oil, grease-laden soils and light rusts: circulate Oakite 77. Heavy-duty alkaline cleaning properties make Oakite 77 superior for penetrating, dissolving and dispersing heavy-oil and carbonaceous soils. It picks up light rust, too . . . leaves towers and tubes in top operating condition.

In cases where extra boosting power is called for to remove abnormally stubborn soils—add Oakite Acalaid to your cleaning solution. This brand new additive permits deeper penetration of soils . . . intensifies the purging action of your acid or alkaline cleaning agent . . . gives you a speedy, economical answer to your toughest tower-cleaning problem.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

with an Oakite ECP

engineered cleaning program

A 90-foot tower cleaned in 15 hours . . . crude tower and heat exchanger purged to 99% cleanliness in 21 hours . . . partly plugged bundles saved from the scrap pile in just a few hours . . . 3½ *days* cut from previous record for cleaning an absorber . . . 5 days slashed from catalytic reformer turnaround time. These are *some* of the results of Oakite technical service.

In each case, the procedure was initiated through the tower and tube bundle recommendations of an Oakite ECP. Did they save time, save cost, save trouble? You bet!

WHAT IS OAKITE ECP?

It's an Engineered Cleaning Program that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation—tower by tower, valve by valve.

The Oakite engineer lends personal and experienced supervision to each phase of the program. He supplies detailed instruction based on practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by materials known to make short work of refinery soils, by proved *methods.*

Ask the Oakite Engineer to recommend the best procedure for your next turnaround and follow up with an ECP for your refinery. Or, send for Bulletin F-10102 on tower and heat exchanger cleaning. Write Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

OAKITE

over 50 Est. 1909 SCIENCE

years' leadership in industrial cleaning

Oakite ECP

your economy key

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Agip Mineraria, S.p.A. Italy • **Antar Pétroles de l'Atlantique** France •

"Aquila" Italy • **Bay Refining Company** Michigan • **Century Refining Company**

Kansas • **Chinese Petroleum Corporation** Formosa • **"Condor"** Italy •

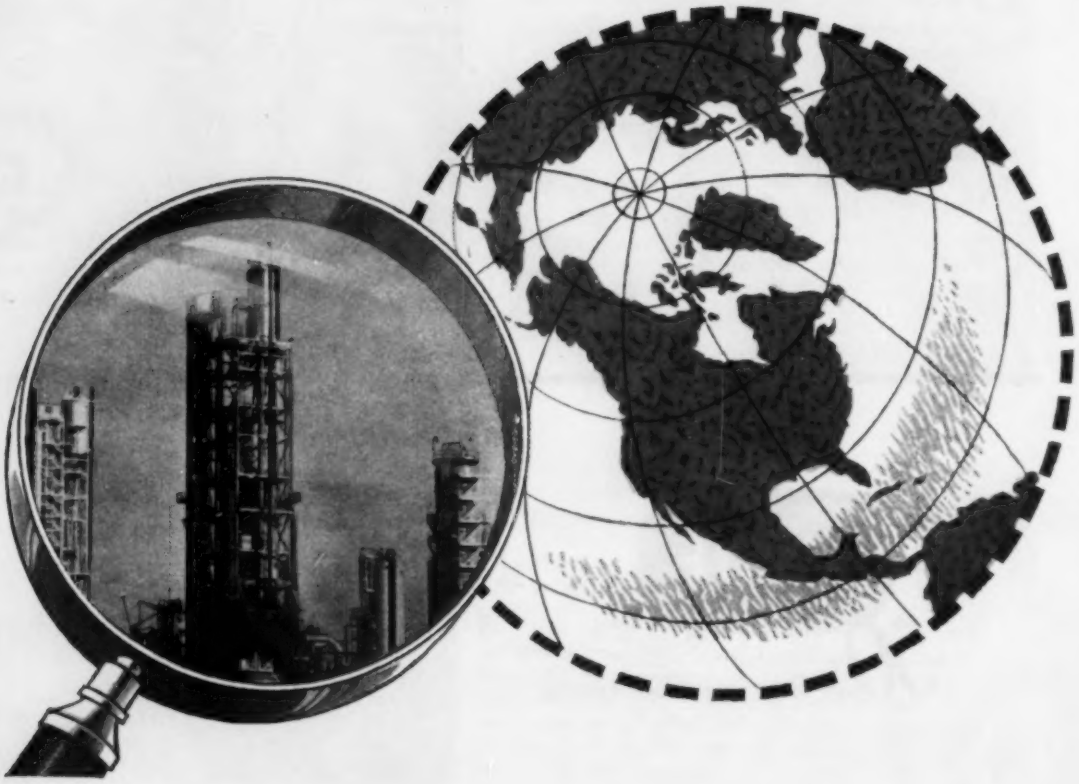
Continental Oil Company Louisiana/New Mexico • **Delhi-Taylor Oil Corporation** Texas •

Delta Refining Company Tennessee • **Derby Refining Company** Kansas •

Deutsche Erdol, A.G. Germany • **Gelsenberg Benzin, A.G.** Germany •

Great Northern Oil Company Minnesota • **Neste, OY** Finland •

IN 13 COUNTRIES...



FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

"Petrofina," S.A. Texas/Italy • **Petróleos Mexicanos** Mexico • **Phillips Petroleum Company** Oklahoma/Utah • **Pontiac Eastern Corporation** Mississippi • **Ruhrchemie, A.G.** Germany • **Sacor** Portugal • **Shamrock Oil and Gas Corporation** Texas • **Signal Oil and Gas Company** California • **Société Chérifienne des Pétroles** Morocco • **Standard Oil Company (Ohio)** Ohio • **Standard-Vacuum Oil Company** Australia/Philippines • **Turkiye Petrolleri Anonim Ortakligi** Turkey • **"União"** Brazil • **Vickers Petroleum Company** Kansas

30 COMPANIES

are saving money with Airlift TCC

Construction costs on Socony Mobil's Airlift Thermofor Catalytic Cracking units have been cut almost in half during the past ten years—a result of continuing Mobil research.

Operating costs have also been reduced. Three years ago Mobil introduced the Durabead catalyst, opening new money-saving horizons in TCC operation. Today's improved Heavy Durabead catalyst brings still greater economies.

Around the world, 51 Airlift TCC units are turning oil into money for 30 companies. Thirty-five of these units are operated under license from Socony Mobil by the 29 companies listed above. Two more units are now under construction, in Mexico and the Philippines. Mobil, itself, brings the company total to 30. Mobil has installed 16 Airlift TCC's in its own refineries in the United States and Europe.

For any refiner interested in the TCC, Mobil will help work out the best processing procedures and cracking yield patterns for a given crude. Address inquiries to Process Promotion Department, Socony Mobil Oil Company, Inc., 150 East 42nd Street, New York 17, N. Y.

SOCONY MOBIL OIL COMPANY, INC.

Leader in Refining Research

Mobil

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Low-cost way to sweeten gasolines

In many refinery stocks, you can convert mercaptans to less odorous sulfur compounds with Du Pont Antioxidant No. 22.

This type of treating can produce a doctor sweet gasoline, and may save money for you in several ways.

You may save equipment costs, since AO-22 sweetening requires little more than a modification of existing equipment.

You may save on additional chemicals and on regeneration expenses—and you don't lose any gasoline or octane numbers in the process.

You will eliminate the chance of contamination by sulfur or copper, because sweetening with AO-22 does not require their use.

Stabilizing, too And finally you combine sweetening *and* stabilizing at one time. AO-22 retards gum formation and protects the quality of your gasoline in storage.

Figure the economics for yourself, or ask us to. Contact your Du Pont representative, or write to: E. I. du Pont de Nemours & Co. (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

DU PONT

Better Things for Better Living . . . through Chemistry

Lead Antiknock Compounds

and other PETROLEUM ADDITIVES

special issue editors

W. E. ASKEY
The Pace Co.
Houston, Texas

Catalytic cracking is the forte of **W. E. Askey** and **W. J. Service,** special editor team for this issue of *Petro/Chem Engineer*.

Askey and Service, both registered professional engineers, are partners in The Pace Company, Houston, Texas, process consultants and design engineers for the refining and petrochemical industries. Before joining Pace in 1957, both were members of the technical organization at Humble Oil & Refining Company's big Baytown, Texas, installation.

Askey, a native of Las Animas, Colorado, is a chemical engineering graduate of Oklahoma State University. He worked in cracking and reforming at Humble, where he was concerned with development of platinum catalyst for catalytic reforming. He holds seven patents, is author of several technical articles, and is a member of the American Institute of Chemical Engineers.

W. J. SERVICE
The Pace Co.
Houston, Texas

Service, who hails from Detroit, Michigan, received a PhB degree from the University of Chicago and BSE and MSE degrees with major in chemical engineering from the University of Michigan. At Humble he was active in crude distillation and catalytic cracking feed preparation. He has to his credit a number of technical articles and one patent. He is a member of Tau Beta Pi, Phi Lambda Upsilon, Phi Kappa Phi, and AIChE.

Both Askey and Service reside in Baytown. Askey and his wife, the former Anabel Holmes, have six children, while Service and his wife, who was Geraldine Ellen McDowell, are parents of three.

This issue climaxes months of effort by our special issue editors. After outlining the main topics they felt the issue should cover, they helped obtain the services of experts best qualified to write on these subjects. The result is an issue which we believe makes a real contribution and will have lasting reference value for the industry. Our sincere thanks to Warren Askey and Bill Service for a job well done.

Warren E. Askey
The Pace Company
Houston, Texas

Highlights for HPI

2nd International

A QUANTITY OF IMPORTANT DATA of interest to the petroleum and chemical industries came out of papers and discussions at the 2nd International Congress on Catalysis in Paris last July. In general, the catalyst characteristics and mechanism of catalysis were emphasized more than the reactions and reaction kinetics. Because we believe most engineers concerned with petroleum processing would benefit by a summary of the papers, *Petro/Chem Engineer* has arranged an interview between Dr. Heinz Heinemann, president of the Congress, and W. E. Askey, a consultant on catalytic cracking. Mr. Askey has reviewed the most significant papers pertaining to catalytic cracking and prepared abstracts of each which will precede the questions and answers. Mr. Askey will question Dr. Heinemann, who will give you his first-hand discussion of this important Congress.

Q. *Dr. Heinemann, to lead off, will you give us some background information on the International Congress on Catalysis?*

A. Plans for the 1st International Congress on Catalysis originated in The Catalysis Club of Philadelphia. It was felt no organization existed through which people interested in the field of catalysis could meet periodically to exchange ideas, and through which discussions between the different schools of catalysis could be sponsored. The Catalysis Club of Philadelphia and the Catalysis Club of Chicago joined with the University of Pennsylvania and the National Science Foundation in sponsoring the 1st International Congress on Catalysis. It was held in Philadelphia in September 1956. The committees organizing the Congress decided to incorporate, and the International Congress on Catalysis, Inc., was set up as a Pennsylvania non-profit corporation in 1956. Its officers consist of a president, treasurer, and secretary and a board of directors composed of nine persons. The board is elected at a membership meeting at each International Congress. All persons attending the Congress are members. The board then elects the officers and determines when and where the next Congress will be held. I was executive secretary of the 1st International Congress and was elected president when the corporation came into being in 1956. My term ran to the 2nd International Congress on Catalysis. Dr. Adalbert Farkas was elected by the new board to succeed me as president.* The 3rd International Congress on Catalysis will be held in Amsterdam in 1964. The purpose of the Congress is to enable scientists and engineers interested in the field of catalysis to congregate and exchange ideas. Presentation of papers is limited to five minute summaries of pre-printed papers and the bulk of the time is reserved for discussions. The 1st Congress was attended by about 700 persons, of whom about 100 came from abroad. The 2nd Congress was attended by 1100 persons from over 30 countries. The American delegation consisted of about 220 persons. The largest delegation was, of course, French, since the congress was held in Paris. Great Britain, Germany, Holland, the Soviet Union, and Italy were all represented by large groups while many countries had one to five representatives.

"Relationship between Acidity of Silica-Alumina Catalysts and Activation Energy for the Formic Acid Decomposition," by J. B. Fisher and F. Sebba.

A series of silica-alumina catalysts was prepared by vapor phase hydrolysis of the chlorides of silicon and aluminum and used in thermal decomposition of formic acid. The activation energy for each catalyst was determined as well as the acidity of the catalyst, determined by n-butylamine titration, and a definite relationship is found to hold between these two parameters.

This table shows the results of acidity and activation energy measurements for several catalysts:

Sample	Dry Basis % Al_2O_3	Activation Energy, E kcal/mole	Acidity, meq/g
A	100.0	21.4	0.000
B	0.0	13.7	0.0325
C	44.9	11.9	0.0433
D	36.6	11.0	0.0938
E	33.3	10.5	0.0950
F	6.7	8.7	0.250
G	11.0	8.3	0.300
H	5.5	8.7	0.325
Commercial Catalyst	13.0	11.7	0.478

* Dr. Farkas is the Assistant Director of Research for Houdry Process Corporation, Philadelphia, Pa.

A plot of activation energy against acidity is shown in Fig. 1.

This curve shows there is a definite relationship between activation energy, E, and acidity. It is interesting that pure

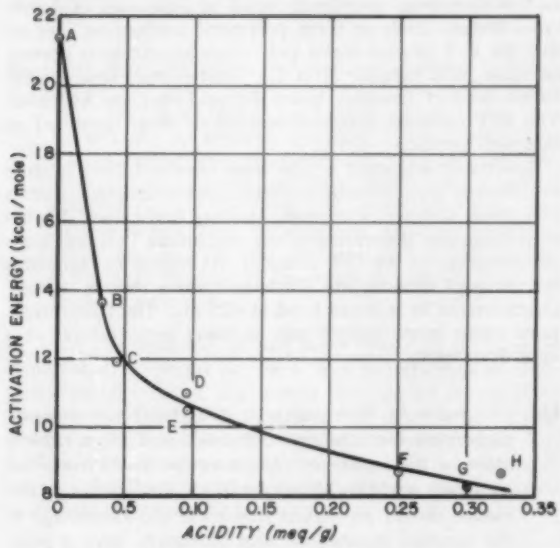


FIG. 1. Activation energy vs acidity.

silica falls neatly into place on the curve. The anomalous values of the commercial catalyst show there must be some other factor in addition to acidity which plays a role in this reaction, because although its acidity is high (0.478 meq/g), its activation energy is somewhat higher than would be expected. Nevertheless, it is a good catalyst, probably because its surface area seems to be very much higher.

Q. *Is there any practical significance of the acidity, alumina content, and activation energy levels presented in this paper?*

A. I am afraid I must admit I have not found any practical significance in the data reported in this paper. I believe the inference to be drawn from the data is that the activation energy for formic acid decomposition is related to something that is relatable to titrable acidity. Perhaps it can be related to acid strengths, assuming that this varies smoothly with alumina content.

Q. *Do you have any opinion as to why the commercial catalyst did not fall on the curve with the laboratory catalyst?*

Dr. Heinz Heinemann
Assistant to the Vice President
Research and Development
The M. W. Kellogg Company
New York

A. I am not in a position to discuss this question because data on the commercial catalyst are not sufficient. I can only suppose that possibly it is due to the commercial catalyst of unknown history having not been calcined. This may account for the high acidity which would be reduced upon calcination or after a few regenerations.

"Structure and Chemical Characteristics of Cracking Catalysts by Ion Exchange," by J. D. Danforth.

Titration curves, solution acidities, and cracking catalyst activities in the presence of equivalent amounts of potassium chloride and barium chloride have been determined by a technique requiring an individual sample for each point on a titration curve. The exchange of cracking catalysts has been compared with that of a typical resin exchanger. In the correlation of these data several structural and chemical characteristics of cracking catalysts are suggested.

The relationship of catalyst activity to catalyst acidity is not a simple one. While neutralization of all acid sites eliminates cracking, activity may be greatly reduced in catalysts which still contain significant amounts of acidity.

Thus, potassium chloride exchanged catalysts show acidities up to 0.28 meq/g but their activity for cracking cumene was greatly reduced or entirely eliminated. Similarly, a carbonized catalyst lost most of its activity but retained almost all of its exchange acidity. While burning off the coke from a carbonized catalyst restores acidity and activity, the regeneration of exchanged catalysts with ammonium chloride restored a major portion of their initial acidity. But in the potassium exchanged catalysts their activity remained far below that which would be expected from their acidity. Furthermore, the acidity and activity of exchanged catalyst remain after the removal of significant quantities of alumina from the catalyst surface. These miscellaneous observations of the relationships between activity and acidity seem to be best correlated by assuming more than one type of strong acid site.

For purposes of discussion it is simpler to assume two types of strong acids, one active for cracking and the other inactive. Variations in the proportions of active and inactive sites will account for the differences in activity which have been reported for catalysts of similar acidity.

In addition to the complexities introduced by several types of acid sites, it seems certain that each type of site can be neutralized by aluminum hydroxide to form an inactive site. The extent to which this neutralization occurs will certainly influence the exchange acidity and activity of a catalyst.

Finally, it appears as though substantial portions of the strong acid sites are too far apart to be converted into exchanged and inactive structures by the divalent barium ion. However, weak acid sites which may be silicon hydroxyls are apparently close enough to all strong acid sites to permit their neutralization at high pH.

Q. *I am most interested in knowing what the reaction of the Congress was to the paper by Danforth. He reached some conclusions about the type of acidity and the number and nature of the acid sites. It seems to me that some of these statements would be controversial and the comments on this paper should be of interest.*

A. Unfortunately, I did not hear much of the discussion of this paper. I agree that this paper was very controversial. One of the main objections I have to the conclusions reached is the attempt to deduce catalytic properties at 400 C in a vapor phase hydrocarbon reaction from properties of the materials studied at room temperature in an aqueous system.

"The Electronic Spectra of Olefins Adsorbed on Silica-Alumina Cracking Catalyst," by A. N. Webb.

Ultraviolet and visible spectra of 1, 1-diphenyl-ethylene, butene-2 and ethylene chemisorbed on SiO_2-Al_2O_3 cracking catalyst have been observed in transmission through compressed discs of powdered catalysts. The adsorbed species and adsorption sites have been identified by comparison with the spectra of known materials from the effect of various reagents.

Two different adsorbed species of each olefin are obtained. Bands at 420 and 330 $m\mu$ are identified with the carbonium ion of $\phi_2C = CH_2$. Butene carbonium ion absorbs only at the shorter wave length. The principal bands of the second adsorbed species identified as a charge-transfer (C-T) complex, are found at 600 $m\mu$ for $\theta_2\ C = CH_2$ and at 380 $m\mu$ for butene.

The carbonium ion species is considered to form a direct carbon-aluminum coordinate bond at acid sites of Lewis type. Butene tends to form polymeric carbonium ions so that the C-T species forms only when an excess is present or upon mild heating (100 C). Diphenylethylene readily forms the C-T complex when the acid sites are hydrated. The C-T complex involved non-acidic sites, identified as hydroxyl groups.

Spectra of adsorbed butene were observed after heating at different temperatures in closed and evacuated systems of varying degrees of dryness. Heating first causes depolymerization and desorption of the carbonium ions and leads to formation of the C-T complex. At higher temperatures the complex desorbs and reacts to form a residue "coke," characterized by a broad band at 425 $m\mu$. The transformations occur more rapidly and at lower temperatures in a very dry system.

Q. *The paper by Webb suggests it is possible to measure carbonium ions and that this could lead to an explanation of the nature of chemisorption of hydrocarbon on Lewis acid sites. It occurs to me that studies of this nature should significantly increase the knowledge of the reaction mechanism and ultimately have a practical significance in catalytic cracking. May we have your comment, Dr. Heinemann, on this paper?*

A. Webb's paper certainly indicates it is possible to measure concentration of carbonium ions. I believe this should lead to an understanding of chemisorption on acid sites but doubt it would give an explanation of the mechanism involved. Webb's argument for a charged-transfer complex was heavily attacked during the discussion. It appears to me the paper by Leftin and Hall* offers a technique and interpretation that considerably advances the use of spectral techniques in the study of reaction mechanisms. I have no doubt that the general technique used in these two papers, and particularly the comparison of infrared and ultraviolet spectra, will greatly enhance our understanding and eventually permit application of the newly gained knowledge in commercial catalytic reactions.

"Influence de Quelques Nouvelles Propriétés Physico-Chimiques des Catalyseurs Silice-Alumine sur Leur Activité Dégradante," by Y. Trambouze, M. Perrin, J.-L. Weill, D. Barthomeuf and M. Prettre.

* "A Spectrophotometric Study of the Mechanism of Chemisorption of Paraffin Molecules on Silica-Aluminum Catalysts."

These authors have investigated the exothermic transformation which takes place with silica-alumina cracking catalyst at 580 C. This irreversible transformation is accompanied by a sharp decrease in acidity and activity. The temperature at which the transformation takes place is lowered when the catalyst is heated in the presence of water vapor.

The authors conclude that the transformation is not purely structural in nature (i.e., gamma to alpha alumina) but that it is due to neutralization of acid sites by OH ions released by dehydration. A further conclusion that the sites so affected must be Lewis acid sites and not protonic sites.

The authors summarize the transformation mechanism as follows:

- During the heating process the gel's acid protons unite themselves to the neighboring OH and this dehydration creates the acids of Lewis centers.
- At a temperature of about 550 C the OH which is strongly retained in the catalyst starts to migrate but reaching the surface fixes itself with a strong output of energy on the Lewis centers which they neutralize.

Q. *This paper suggests a deactivation occurring in silica-alumina at 580 C which was irreversible and exothermic. The deactivation mechanism suggests that acid centers are neutralized. Further, steam lowered the temperature of the transformation. Since this temperature is in the range of operating conditions found in a catalytic cracking unit regenerator, I believe these data may well lead to a definition of optimum operating temperatures. Also, this may explain some of the deactivation occurring by steam injected into or produced in the regenerator.*

A. My interpretation of this paper was that the type of deactivation occurring at 580 C was irreversible and complete. On once taking the sample through the critical temperature, the reaction is complete and there is no further exothermicity if the sample is heated a second time to 580 C. The reaction seems to be very rapid. It is, of course, possible that the mechanism suggested is the one that leads to the loss of activity by steaming.

"Kinetics of Heterogeneous Catalytic Flow Reactions," by G. M. Panchenkov.

The author studied the kinetics of coke deposition on silica-alumina catalysts in cracking of both individual hydrocarbons (cetane-decalin) and a gas oil fraction. Based on the concepts that coke deposits on the surface where the reaction of cracking of hydrocarbons occurs and that the deposit of coke is a polymolecular layer, the author has deduced for this scheme an equation for the kinetics of the coke deposition, which is in good agreement with the experimental data and has the form:

$$C = A\theta + B\,[1 - e^{-D\theta}] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where C is the percentage of coke deposited on the catalyst surface, θ is the time, A, B, and D are constants. These constants, although having quite a definite physical sense, cannot be theoretically calculated, but they may be readily estimated from experimental data on the kinetics of coke formation.

Knowing the constants of the previous equation, it is easy to calculate the active surface area. The latter estimated per 100 grams of a catalyst is equal to

$$S_0 = \frac{2.35 \cdot 10^3\,(B\,D + A)}{D} \quad . \quad . \quad . \quad . \quad (2)$$

Thus, if the assumption that coke deposits on the sites of the overall catalyst surface where hydrocarbon conversions occur is true, an investigation of the coke deposition kinetics would make it possible to evaluate the magnitude of the catalyst surface area where a chemical reaction proceeds. This value is of very great interest since so far there are no valid methods for estimating the catalyst surface area where a chemical process occurs.

The calculated active surface areas of silica-alumina catalyst in cracking of cetane, decalin and a gas oil fraction are given in the following table:

Feed	Temperature C	Active Surface Area m/g	Active Surface Area % of the total catalyst surface found by methyl alcohol sorption
Cetane	430	20.6	6.8
	450	20.6	6.8
	500	24.9	8.2
Decalin	430	10.4	3.4
	450	12.5	4.1
	500	19.4	6.4
Kerosine-gas oil fraction	450	29.2	9.7

As can be seen from this table, the active surface area is larger for cetane than for decalin, which may be readily accounted for by the geometric sizes of molecules (the accessible surface should be greater for cetane than for decalin). In addition, the table shows that the active surface area increases with rising temperature, which is apparently due to thermal expansion of the catalyst and to the appearance of additional active sites.

Q. *This paper presented reaction kinetics which were of interest in the field of catalytic cracking. A mechanism of coke deposition on the surface of the silica alumina catalyst was suggested. In addition, an equation for coke deposit was presented. I would be interested in knowing how this theory and equation fit previous concepts.*

A. I agree that this paper was extremely interesting. The derivation of the equation for coke deposit was, unfortunately, not given in this paper and was promised for a later publication. The conclusions Panchenkov gives sound plausible. The relationships between the amount of coke deposited on a silica-alumina catalyst and the time of cracking is in good agreement with the finding by others that percent coke deposited is independent of pressure.

Q. *Were there any other papers you feel would be of particular interest to engineers in the HPI, Dr. Heinemann?*

A. There were, of course, a considerable number of other papers of appreciable interest to the petroleum and petrochemical industries. I should like to mention Kearby's paper on "New Aluminum Phosphate Gels as Catalysts." It appears that a new species of acid gel has been made available to extend the areas previously studied with silica-alumina and alumina gels. The mechanisms of hydrogenation of acetylenic compounds in admixture with olefins was studied in a paper by Hamilton and Burwell. The kinetic investigation and its conclusions are particularly elegant.

Note — Editions TECHNIP, 2 rue de Lubeck, Paris (16e) France will publish the complete proceedings of the Congress. These proceedings will contain the papers we are discussing here as well as all other papers presented at the Congress and the discussion following presentation of these papers. ★ ★ ★

What you should know about

catalytic cracking

Important principles of catalytic cracking considered from the practical standpoint are discussed in this two part series.

Part I. Kinetics . . . Catalysis

Part II. Fluidization

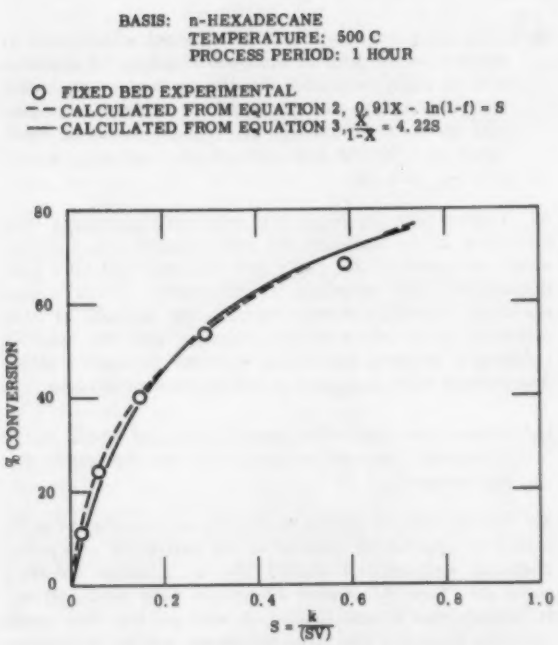


FIG. 1. Comparison of calculated and experimental conversions.

CATALYTIC CRACKING is one of the most important petroleum processes and in many respects is the heart of the modern refinery. The success of the catalytic cracking process can be attributed largely to its selective nature as compared to thermal cracking. Although the catalyst greatly increases the cracking rates over purely thermal rates, its most significant influence is to produce much more valuable products such as high octane gasoline and desirable light olefins and isoparaffins. The difference in the type of products produced in the thermal and catalytic cracking processes is due to the different mechanisms involved in the two cases. Catalytic cracking proceeds according to a carbonium ion mechanism while thermal cracking occurs via a free radical mechanism.[1]

A. KINETICS OF CATALYTIC CRACKING

A theoretical treatment of catalytic cracking reactions is difficult because of the tremendous complexity of the system. Each feed component undergoes many different types of reactions, including both primary and secondary reactions. Primary reactions are defined here as the initial reactions of the feed while secondary reactions are considered to be the reactions which the primary cracked products undergo. Estimation of the various reaction rates is complicated not only by the large number of simultaneous reactions occurring but also by the rapid and variable decline in catalyst activity which accompanies the cracking reactions. This rapid rate of catalyst fouling or deactivation has been well demonstrated by Blanding[2] and others. For any given reaction and state of catalyst deactivation, a rigorous kinetic treatment should consider the various individual steps in the cracking reactions involved. These would include mass transfer of reactants to the catalyst surface, diffusion into catalyst pores, chemisorption on active sites, surface reaction via a carbonium ion mechanism, desorption and diffusion of products and reactants from the catalyst pores, and mass transfer back into the vapor phase. The problem associated with a fluidized catalyst bed and the effect of fluid dynamics on the catalytic cracking yield structure is discussed in a later section.

In spite of the difficulties and problems involved in a theoretical analysis of the catalytic cracking reactions, there is much to be gained by even a simplified fundamental treatment of the principal reactions involved. There are many reasonable simplifying approximations which can be made to reduce the system to workable proportions. In the normal commercial operating region of reactor temperature, 900 to 1000 F, and catalyst particle size, 10 to 100 microns, mass transfer and diffusion[2] are of minor importance compared to adsorption and surface reaction. The available evidence indicates that in general the cracking reactions are rate limited by a single site surface reaction.[3] The separation of adsorption effects from the surface reaction poses a difficult problem because they are so closely associated. However, in the practical case, this may not be too important since both effects can be represented by the same form of equation.

J. F. CROCOLL • R. D. JAQUAY
Senior Research Engineers
Houston Research Laboratory, Shell Oil Company

Over-all rate of feed conversion

Many expressions have been proposed which relate feed conversion to a severity factor at constant catalyst activity. Almost all of these have been derived on the assumptions that the surface reaction and/or adsorption is the rate limiting step and the reaction is unidirectional and first order. The form of these expressions varies somewhat depending on the assumption made in regard to adsorption and volume expansion. The Freundlich and Langmuir types of adsorption isotherms have both been used to estimate the amount of reactant or feed adsorbed on the catalyst in a reactive situation. The cracking occurring in the reactor gives rise to a considerable volume expansion which must be considered in the over-all rate equation. The most frequent assumption made here is that the moles of cracked product per mole of feed cracked is constant. Actually, the moles of cracked product per mole of feed cracked increases somewhat with severity because of extensive secondary reactions, principally olefin cracking.

If a Langmuir adsorption isotherm is assumed, the differential equation for cracking becomes,

$$-\frac{dF}{dt} = \frac{k\, b_f\, p_f}{1 + b_f p_f + \Sigma b_i p_i} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where F = moles of feed
t = time
k = reaction rate constant
b = adsorption equilibrium constant
p = partial pressure
Subscript f refers to feed, i to product

Assuming a constant volumetric expansion factor and considering the possibility of diluents in the feed, the above equation integrates to

$$DX - C \ln (1 - X) = \frac{k\, b_f\, \alpha \pi}{(SV)} \quad . \quad . \quad . \quad (2)$$

where $D = b_f \alpha \pi - \alpha(q-1) - b_i q \alpha \pi$
$C = 1 + \alpha\ (q-1) + b_i q \alpha \pi + b_j\,(1-\alpha)\pi$
X = fraction of feed converted
α = mole fraction of oil in feed
q = moles of product formed per mole of feed cracked
π = absolute pressure
(SV) = space velocity
Subscript j refers to inerts

This type of equation has been found by Frost,[4] Voge,[5] and others to describe the over-all cracking reaction quite well. The fact that this is true does not necessarily substantiate the assumptions which were made since the curve described by this function is quite variable depending on the values of the constants used. In this connection, it is interesting to compare Blanding's conversion function, which was derived on the basis of different assumptions, with Equation 2. In his derivation, Blanding[2] assumed a Freundlich type adsorption isotherm with an exponent of 1 and furthermore considered that the volumetric expansion factor, q, was not constant but rather increases substantially with depth of cracking. These assumptions led to the following equation:

$$\frac{X}{1-X} = \frac{k\,\pi}{(SV)} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Conversions calculated from Equation 2 and 3 are compared in Fig. 1 with experimental conversions obtained with n-hexadecane in a fixed-bed unit at 500 C and a 1-hr process period. It will be observed that in spite of the different assumptions made in the two cases there is little difference in the calculated curves and both equations satisfactorily describe the experimental data out to reasonably high conversions.

The above conversion equations were derived for the case in which the feed moves in a plug flow fashion through the bed. Vapor back mixing in the bed causes the feed to be diluted with cracked products, thereby requiring a higher severity for a given conversion as compared to plug flow. By definition the well-mixed case requires that the concentration of feed and products be the same in all parts of the reactor and equal to that in the reactor outlet. The rate equation in this instance becomes simply a difference equation requiring no integration. To illustrate the case of complete vapor mixing, Blanding's approach leads to Equation 3a, below, as the counterpart of the plug flow Equation 3:

$$\frac{X}{(1-X)^2} = \frac{k\,\pi}{(SV)} \quad . \quad . \quad . \quad . \quad . \quad (3a)$$

A comparison of plug flow Equation 3 with the complete mixing Equation 3a shows that the latter case requires twice the plug flow severity to obtain a conversion of 50%.

Although pilot plants frequently approach the plug flow case, commercial dense bed reactors are intermediate between the plug flow and well-mixed case but somewhat closer to the latter.

The above equations for conversion do not consider any reverse reactions whereby feed boiling range components are synthesized from product components, such as olefins. Also, no allowance has been made for the increase in refractoriness of the "unreacted" feed with depth of cracking. Commercial feed stocks contain a number of different hydrocarbon species, each of which spans a wide range of molecular weights. Obviously, a fundamental treatment should

consider the principal hydrocarbon types and their various molecular weight ranges as individual feed components and should also provide for synthesized components in the feed boiling range.

Selective adsorption and catalyst deactivation

As previously mentioned, the activity of the catalytic cracking catalyst decreases very rapidly during its residence time in the reactor. Although this deactivation is frequently attributed to coke formation on the catalyst, it also appears that strong selective adsorption of small quantities of materials such as highly condensed aromatics, basic nitrogen, and resins play an important role in catalyst deactivation. Obraidchikov and Soskind,[6] in their work on a system of saturates and diaromatics, found the rate of saturate cracking to be markedly inhibited by the diaromatics at constant coke on catalyst. Prater and Lago,[7] in their cracking experiments with cumene and an East Texas light gas oil, showed that the activity of a spent catalyst could be largely restored by high-temperature desorption of about 20% of the original coke in an oxygen-free environment. This desorbed material was found in subsequent experiments to have a strong inhibiting action on cumene cracking. They concluded, therefore, that the high-temperature treatment of the spent catalyst restored catalyst activity by stripping off small amounts of strongly adsorbed materials rather than by a decomposition process yielding carbon, hydrogen, and free active sites as had previously been suggested.[8]

It has been shown by Voorhies[9] that the decline in catalyst activity with process period can be represented by:

$$A = \frac{a}{t^n} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where A = activity of catalyst at time, t
t = time
n = exponent of approximately ½
a = constant

Although this equation holds quite well over a moderate range of t, it could not be expected to be accurate at very short or very long process periods since it requires the initial catalyst activity to be infinite and the final activity to be zero. An expression applicable to a wider range of process periods can be derived as follows. Consider catalyst activity to consist of two parts,

$$A = A_1 + A_m \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where A = total catalyst activity at time, t
A_m = limiting residual activity of the coked catalyst
A_1 = activity of catalyst subject to deactivation

From Blanding's data[2] it appears that the rate of catalyst deactivation proceeds at a rate proportional to the square of the instantaneous activity or,

$$-\frac{dA_1}{dt} = C_1 A_1^2 \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Integrating and letting A_o = initial catalyst activity, the following expression is obtained for the instantaneous catalyst activity,

$$A = \frac{A_o}{1 + C_1 A_o t} + A_m \quad . \quad . \quad . \quad (7)$$

Equations 7 and 4 are compared with Blanding's experimental data in Table 1.

Table 1. Comparison of Calculated and Experimental Instantaneous Catalyst Activities.

Time, Minutes	Blanding's Exp. A's	$A = \frac{200}{1 + 8.7t} + 0.50$	$A = 11.2\,\theta^{-\frac{1}{2}}$
0.0167 (1 sec)	175	175	87
0.167 (10 sec)	65	82	27
1	19	21	11
5	5.0	5.0	5.0
10	3.0	2.8	3.5
20	1.9	1.6	2.5
50	1.0	1.0	1.6
200	0.6	0.6	0.8

Although the additional constant in Equation 7 has theoretical justification, it is recognized that an additional constant in itself improves the goodness of fit. Equation 6 can be integrated in the usual fashion to obtain suitable expressions for the average activity in a fixed bed or a moving bed. In the latter case, consideration must, of course, be given to the whole spectrum of residence times of the individual catalyst particles.

Relative reaction rates

Although conversion or feed disappearance functions of the type discussed above are important, relative reaction rates and the product distributions which they lead to are of more importance to the refiner. The amount of coke produced relative to gasoline and other products is of particular interest since most commercial units are limited by their coke burning capacity. Because of the importance of relative yields ,it is common practice to plot individual product yields versus conversion, the sum of all the cracked products. In order to calculate or predict relative product yields it is necessary to consider the differences in the cracking behavior of the major hydrocarbon types present in catalytic cracking feed stocks as well as the secondary reactions which are common to all feed components. Therefore, any fundamental treatment of catalytic cracking which considers the feed to consist of only one component is not very meaningful because of the tremendous differences in the cracking behavior of the various species. Some of the more important differences to be considered are discussed below.

Saturates

Catalytic cracking feed stocks contain large quantities of saturates consisting of both paraffinic and naphthenic types. These two saturate types are both desirable feed components although they do have somewhat different cracking patterns.[5,11] Naphthenes crack faster than paraffins and in addition produce more gasoline and coke and less gas than the latter. Both saturate types yield gases rich in C_3 and C_4 components. The low yield of C_2 and lighter gases compared to thermal cracking can be attributed to the carbonium ion mechanisms prevailing in catalytic cracking. Greensfelder[11] and others have shown that the formation of C_2 and C_1 fragments in catalytic cracking is not a prominent reaction since reactions producing the sec-propyl and tert-butyl carbonium ions are energetically more favorable. The tertiary ion is particularly reactive and plays an important role in hydrogen transfer reactions to produce isoparaffins. The selective saturation of tertiary olefins in catalytic cracking results in a very high ratio of iso-to-normal butane compared to thermal cracking. The iso-to-normal ratio may be far above the isomerization equilibrium. Since olefin saturation occurs largely via a hydrogen transfer mechanism rather than by a direct hydrogenation mechanism, the extent of saturation is dependent on the type of hydrogen donors present. Naphthenes are more effective hydrogen donors

than paraffins and hence they produce C_4 and C_5 fractions richer in isoparaffins.

A characteristic feature of saturates is that they apparently rupture in several places simultaneously[6] to yield largely gasoline and lighter products. Catalytic cracking data obtained by Greensfelder[1] and co-workers with cetane indicated that a uniform cracking pattern prevails; i.e., the fraction of feed cracking to the various products remains reasonably constant over a wide range of operating severities. The change in product distribution observed with severity is due to secondary reactions. It was also found that very little C_{10} to C_{15} product was formed at any severity. It seems probable, therefore, that high molecular weight saturates do not form appreciable amounts of light gas oil product upon cracking. The rate of cracking of all saturates increases rapidly with molecular weight. Since secondary cracking reaction rates responsible for gasoline destruction and coke formation are not appreciably affected by feed mole weight, gasoline yield increases and coke make decreases with increase in feed molecular weight at constant conversion.

Aromatics

The presence of aromatic rings in a molecule greatly alters its cracking characteristics. It has been experimentally demonstrated that aromatic nuclei are remarkably resistant to ring rupture,[10] although they do engage in condensation reactions with themselves and olefins to form more highly condensed structures and coke. The coke-making tendency increases rapidly with the size of the condensed nuclei; i.e., in the order of mono-, di-, triaromatic, etc. The polyaromatic rings in both virgin and cracked stocks are thought to be highly condsensed; i.e., where two or more aromatic rings are present in the same molecule they are fused.[12] Monoaromatics differ from polyaromatics in that the single aromatic ring becomes a gasoline aromatic after sufficient cracking away of the appended saturates. The diaromatic molecules in turn differ from the triaromatics in that the former fall into the light gas oil boiling range after sufficient cracking away of the large saturate appendages. Triaromatic and heavier nuclei are always heavy gas oil components (615 F+) because of their high boiling points. Although aromatic nuclei themselves are virtually incapable of cracking to lower molecular weight products, the saturates appended to aromatic nuclei readily crack away to form a variety of gasoline and lighter products. From these considerations it is evident that the potential yield of gasoline and lighter products from aromatics is directly related to the amount of saturate appendages and monoaromatic rings present.

The cracking of appended saturates occurs very largely adjacent to the aromatic nuclei while the rate of cracking increases with the size of the appendage.[10] Since the larger appendages crack more rapidly than small ones, the initial products are rich in gasoline boiling range components, particularly olefins. However, as the cracking proceeds and the appendages on the average become shorter, a progressively increasing amount of these saturates become too small to form gasoline components and hence they form C_4 and lighter fragments upon cracking. As a consequence of this, the shape of the gasoline-conversion curve for aromatics may be quite different from that for true saturates. It is apparent then that, for the purpose of characterizing the cracking behavior of an aromatic molecule, the several parts comprising it should be considered separately.

Unlike pure saturates, high molecular weight monoaromatics and diaromatics probably form substantial amounts of light gas oil aromatics upon cracking. This would be expected because of the rapid rate of cracking away the large saturate appendages, thereby dropping many aromatic molecules into the light gas oil boiling range. In order to calculate the yield of cracked light gas oil, it is necessary to consider both the rate of cracking of the original feed light gas oil components and the rate at which heavy gas oil monoaromatics and diaromatics crack into the light gas oil boiling range.

Temperature

Temperature is one of the most important process variables in catalytic cracking since it has a large influence on both the severity or depth of cracking and also the relative yields of cracked products. All reaction rates increase with temperature but some increase faster than others. The rate of olefin saturation is by far the least affected by temperature and hence at constant conversion the cracked products are much richer in olefins at high temperatures. The lower yield of gasoline obtained under these conditions is probably associated with the reduced olefin saturation. Since fewer gasoline olefins are saturated to form relatively stable gasoline components, more of the reactive olefins undergo cracking to light gases at the higher temperatures. Since there is a greater rate of destruction of primary gasoline at higher temperatures (secondary cracking of olefins), the shape of the gasoline-conversion curve will depend on the temperature. The rates of condensation reactions leading to coke apparently do not increase quite as fast as the primary cracking reaction rates with temperature and therefore the amount of coke in the converted products is usually somewhat lower at high temperatures. These temperature effects on the relative product yields represent the over-all net effect of temperature on adsorption and the surface reaction, since it will be recalled that over-all relative reaction rates are dependent on the reaction rate times the equilibrium adsorption of the various reactions. The activation energies calculated from over-all rate constants in catalytic cracking are quite moderate[5] since although the reaction rate constants increase rapidly with temperature, the equilibrium adsorption coefficients decrease considerably at higher temperatures.[13] The relationship of over-all rate constants to temperature can apparently be satisfactorily represented by the Arrhenius function even though these constants include adsorption.[2]

Recycle and staged cracking

Undesirable secondary reactions in catalytic cracking result in considerable degradation of the primary gasoline products to gas and coke. Other equally undesirable secondary reactions produce coke from the aromatics present in the feed. These secondary reactions can be minimized by recycle cracking. This mode of cracking utilizes the "lower conversion per pass" principle to reduce secondary reactions. Since both the recycle and fresh feed contribute to the cracked products, a lower severity can be employed to obtain a given fresh feed conversion. The lower severity provides less time for the undesirable secondary reactions to occur. Recycle operation invariably increases gasoline yield and generally reduces coke, although not always.[14] The effect of recycle on coke depends on the type of recycle (light or heavy gas oil) employed and probably feed composition. The concentration of high coke making condensed aromatics builds up in the cracked gas oil and hence this tends to offset the beneficial effect of the lower conversion per pass.

A more efficient method of minimizing undesirable secondary reactions is to crack in stages. In the two-stage catalytic cracking process, recently introduced commercially,[15] the cracked products from a mild first stage crack

are removed prior to the second stage cracking of the remaining "unconverted" feed. Substantially higher gasoline and lower coke yields are obtainable by this stage operation. This two-stage cracking process is discussed in a later section.

Molecular weight of feed

For a given hydrocarbon type, coke yield at constant conversion decreases with molecular weight since the primary cracking rates increase while the secondary reaction rates are not significantly affected. In the practical case, however, the hydrocarbon type composition of the feed obtained from a given crude usually becomes richer in highly condensed aromatics as molecular weight increases. Since the condensed aromatics are large coke makers, the coke yield at constant conversion can either increase or decrease with molecular weight, depending on whether the increase in conversion or the increase in coke predominates. For these reasons, it is difficult to generalize as to the effect of molecular weight unless compositional data are also available.

B. CATALYSIS

Many different types of catalysts can be used for catalytic cracking. These include catalysts composed of silica-alumina, silica-magnesia, silica-alumina-magnesia, alumina-boria, alumina-zirconia-silica, etc. The following discussion on catalysis is concerned with the silica-alumina type; however, with but relatively minor differences, the same over-all aspects should be equally applicable to the other types of catalysts.

Catalyst acidity

The most striking characteristic of all catalytic cracking catalysts is that they exhibit strongly acidic properties. This is true for "natural" catalysts prepared by acid treatment of naturally occurring clays (e.g. Filtrol type catalysts) and for the synthetic silica-alumina preparations. The synthetic catalysts may be prepared from either the "acid side" by hydrolysis of an aluminum salt in the presence of silica gel, or from the "alkaline side" by acidification of mixtures of sodium silicate and an aluminum salt.

Evidence for the acidity of cracking catalysts comes from various observations. During the early investigations of cracking catalysts, a number of studies of catalyst acidity were made using aqueous systems. The methods used have included titration with alkali hydroxide,[16,17] the liberation of acid from catalysts by means of ion exchange,[18,19] determination of the extent of carbon dioxide liberated from a catalyst-bicarbonate solution and the rate of inversion of sucrose.[18] Although these methods proved to be valuable guideposts during the early studies of catalyst acidity, there are certain limitations involved in techniques based on aqueous solutions. These include the facts that water will react with the catalyst surface and thus alter its structure and that water is a relatively strong base and will accept protons from a strong proton acid to form hydronium ions.

On the other hand, vapor phase measurements can be employed to obtain useful information concerning the acidity of catalyst surface. For example, the strong adsorption of ammonia by a calcined silica-alumina catalyst at elevated temperatures is a good measurement of the high acid strength of the catalyst. Along this line data obtained by Roper[20] shows that at any given temperature (up to about 1000 F) the uptake of ammonia is substantially greater per unit of surface for a cracking catalyst than for silica gel and, further, it persists to higher temperatures.

Indicator dyes can be used to characterize the number and strength of acidic groups on the surface of catalysts. Among the early workers in this field, Lewis[23] observed that such acids as aluminum halides could be titrated in a nonaqueous solvent with an indicator dye. Other workers in this field include Johnson and Tamele[24,25] who employed n-butylamine in dried benzene to titrate the acidic groups on the surface of calcined cracking catalysts, Weil-Malherbe and Weiss[26] who observed that certain basic dyes that gave deep colors with strong acids in nonpolar solvents gave similar colors with untreated and acid-treated clays, and Walling[27] who used a series of dye indicators to show that silica-alumina, silica-magnesia, and activated natural catalysts had high acid strength, being equivalent to between 0.1 and 1 N HCl. On the other hand, pure silica and alumina were nonacidic. Other work by Benesi[28,29] using a series of Hammett indicators covering the range of pK_a from $+6.8$ to -8.2 showed that calcined (1020 F) silica-alumina and activated clay catalysts had very high acid strengths. In fact, the strength of the acid sites exceeded that of 90% w sulfuric acid.

Catalyst activity

Having established that cracking catalysts exhibit strongly acidic properties, it is of interest to attempt to relate the catalyst acidity to its activity. This may be done by either preparing separate catalysts of different acidities or by varying the acidity of the same catalyst.

Tamele and co-workers[30] studied the relationship of catalyst activity and acidity for the cracking (932 F) of cumene over a series of silica-alumina catalysts. These catalysts ranged in alumina (Al_2O_3) contents from 0.12% w to 10.3% w and in acidity (milliequivalents/gram as measured by n-butylamine titration) from about 0.05 to 0.35. Results from the cracking tests showed that the catalyst activity increased with increased catalyst acidity.

In the other approach Mills and co-workers[31] showed that ion exchange reactions with an uncalcined Houdry synthetic catalyst involving 1.14 meq K^+/g (milliequivalents of potassium ions/gram) resulted in the catalyst losing essentially all of its cracking activity. This was attributed directly to loss in catalyst acidity; i.e., neutralization of acidic sites by K^+, since there was no change in catalyst surface area and the activity and acidity could be completely restored by exchange of the K^+ with H^+ or NH_4^+. Not only alkali ions but also basic nitrogen compounds will neutralize the catalyst acidity (and activity). Mills and co-workers[31] found that the cracking of cumene could be substantially reduced by the preadsorption of organic nitrogen bases on Houdry silica-alumina catalyst. The extent of deactivation was a function of the basicity of the nitrogen compounds with the more basic compounds causing greater extents of neutralization of the acidic sites and hence loss in cracking activity. The acidity and thus the activity of the catalyst could be restored by simple air regeneration to remove the adsorbed nitrogen bases.

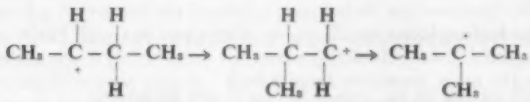
Theory of catalytic cracking

With the establishment of the acidic nature of catalysts and the relationship of activity to acidity, it is now necessary to formulate a theory to explain the reactions occurring during cracking. The "carbonium ion" theory is the generally accepted explanation for the various reactions observed during the catalytic cracking steps. This theory considers cracking catalysts as members of the general group of acidic catalysts and by analogy relates catalytic cracking to the reactions occurring in such other acidic media as aluminum chloride, sulfuric acid, etc. The carbonium ion theory was originally developed by Whitmore[32,33] to explain the results from polymerization of olefins but has since been trans-

planted to catalytic cracking by many advocates.[1,24,35,36,37]

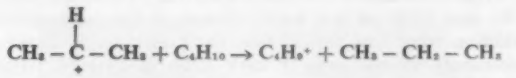
Carbonium ions are defined as the intermediates in catalytic cracking and are electron-deficient entities consisting of a positively charged carbon atom with three monovalent atoms or equivalents attached. There are certain specific rules regarding the formation, rearrangement, and reaction of carbonium ions. The principal rules according to Voge[5] are:

1. A carbonium ion is an easily rearrangeable structure which, by methyl or hydrogen shifts, can form an isomerized ion.

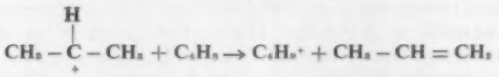


2. The carbonium ion is extremely reactive and can undergo many separate reactions.

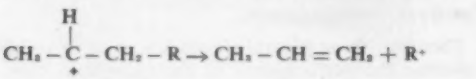
3. The carbonium ion can extract a hydride ion from a neutral molecule to form a new carbonium ion and a new neutral molecule.



4. The carbonium ion can transfer a proton to an olefin and thus become converted to an olefin.



5. If the carbonium ion is large it can undergo beta splitting to form an olefin and a small carbonium ion.



6. The carbonium ions decrease in relative stability according to the series tert > sec > prim > ethyl > methyl. In general, the more stable ions are favored when there is a choice of forming more than one ion.

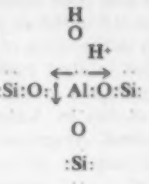
The above rules provide the basis for rationalization of the following observations:

1. Carbon to carbon bonds rupture
2. Compounds with tertiary hydrogens crack easily
3. Long chain olefins and aromatics with alkyl side chains ($> C_3$) crack easily
4. C_2 and lighter fragments are almost never formed during the cracking of straight chains
5. Both double bond and skeletal isomerization occur
6. Hydrogen transfer reactions occur
7. Aromatics form from straight chain compounds

Catalyst chemistry

As stated earlier, neither silica gel nor alumina gel alone is appreciably acidic. That is, the presence of Al-OH, Al-O-Al groups on the surface of alumina; Si-OH, Si-O-Si groups on the surface of silica do not impart acidic properties. On the other hand, chemical interaction of aluminum hydroxide with the silica gel results in strong acidity. During the preparation of synthetic catalysts, the hydrolyzing aluminum ions interact with the silanol group (silica gel) to form Si-O-Al groups on or near the surface. The aluminum atoms become part of the silica complex and may be bound to anywhere from one to three silicon atoms.

A somewhat idealized diagram is given below showing the arrangement of the atoms in the silica-alumina catalyst,[24,30]



According to Tamele and co-workers [24,30] the electrical asymmetry of the Al^{3+}:O:Si^{4+} groups is responsible for the electrophilic property of the aluminum ions on the catalyst surface. In all probability there is a shift in the electron pair in the Al:O bond towards the more highly charged silicon atom (direction of arrows). As this occurs there is a shift in the ionic balances with the aluminum ion becoming more positive and the aluminum-oxygen bond more ionic. With this shift it is possible for the aluminum ion to separate the hydrogen ion from water by aquiring the hydroxyl ion. The split hydrogen ion remains on the catalyst surface as a proton.

During normal calcination of the catalyst, some of the sites become dehydrated. Thus two types of sites exist on the catalyst, some occupied by protons and some dehydrated sites without protons. Mapes and Eischens[21,22] have demonstrated the presence of both types of acid sites by using infrared absorption spectroscopy to study the nature of ammonia chemisorbed (347 F) on a calcined silica-alumina catalyst. Treatment of the calcined catalyst with dry ammonia showed infrared absorption bands similar to those of NH_3 (dehydrated sites without protons) and NH_4^+ in ammonium salts (hydrated sites with protons). Although both types of sites are present, it is believed that the catalytic cracking reactions are promoted by the acid sites containing protons.

Application to catalytic cracking

With the establishment of catalyst acidity as the source of activity and the carbonium ion theory to explain the reactions, it is now necessary to consider the original formation of carbonium ions. The steps involved in the formation of carbonium ions from saturates are not too clearly defined. In the cracking of paraffins, for example, possible routes for carbonium ion formation include:

1. A small amount of olefin is formed by thermal cracking. The olefin is converted to a carbonium ion by addition of a proton from the catalyst.
2. A hydride ion is removed from the paraffin by means of a proton from the catalyst.

Once the carbonium ions are formed, a number of steps are presumed to follow. These include isomerization, cracking to form smaller ions and olefins, splitting of the smaller ions, and removal of hydride ions from additional paraffin molecules to form new carbonium ions to continue the reactions.

With respect to cracking ring structure compounds, the formation of carbonium ions from naphthenes probably occurs in a manner similar to that for the paraffins. On the other hand, the aromatic ring is quite stable and undergoes little reaction itself. Thus for the cracking of alkyl aromatics, the reaction is preferentially a severance of the entire alkyl group from the molecule.

A detailed discussion of the relative reaction rates and the product distributions to be expected from the cracking of these hydrocarbon types is given in the earlier section on kinetics.

Catalyst physical structure, fresh catalyst . . . fresh synthetic silica-alumina catalysts after calcination (900 to 1100 F) have surface areas and pore volumes as high as 600 to 800 sq m per gram and 0.6 to 0.8 cc per gram, respectively. The alumina content is in the range of about 10 to 25% w as Al_2O_3. Each individual catalyst particle probably consists of a loosely packed aggregate of extremely small particles. Electron microscopy studies by Adams and Voge[38] clearly show that fresh calcined American Cyanamid synthetic silica-alumina catalyst consists of roughly spherical micro particles of about 4.5×10^{-3} microns average diameter loosely packed together to form larger aggregates varying in size from about 0.05 to 3 microns in diameter. There is a further packing together of these primary aggregates to form the so-called microspheroidal catalyst. The physical characteristics of the catalyst; e.g., surface area and pore volume, are directly related to the degree of packing of the initial micro particles in forming the ultimate or final catalyst particle. It is of interest to note that the surface area and pore volume of the catalyst calculated by Adams and Voge[38] from the electron micrographs agree quite well with the experimental measurements made by conventional nitrogen adsorption.[39]

Catalyst changes during use

During catalytic cracking operations the circulating catalyst is continuously subjected to conditions of high temperature and steam partial pressure both of which are directly responsible for decreases in catalyst surface area and pore volume. These changes in catalyst physical structure are accompanied by a decrease in catalyst acidity and hence the activity available to initiate the carbonium ion mechanisms. High temperature and steam pressure studies have been carried out in the laboratory to elucidate the mechanisms by which they cause catalyst deactivation.

Fresh silica alumina catalyst can be heated under anhydrous conditions (i.e., vacuum with the resultant continuous removal of water vapor from the system) at temperatures as high as 1560 F with only a small reduction in catalyst surface area and pore volume.[40] These changes are proportionate so that the average pore radius as calculated from the average surface area and pore volume remains constant. However, an increase in temperature of about 100 F to 1660 F results in a complete collapse of the catalyst structure. When steam is added to the system there are significant reductions in both surface area and pore volume at temperatures as low as 1000 F. However, there is a significantly greater change in the surface area than in the pore volume when the steam partial pressure is high, with the net result that the average pore radius becomes increasingly larger with increased temperature of steam deactivation (constant time of deactivation).

Electron microscopy studies of catalyst deactivated under various conditions established the mechanisms by which steam and temperature causes changes in catalyst properties.[38,41] Deactivation by steam at relatively low temperatures (i.e., 1000 F) results in the actual assimilation of the smaller micro particles (see earlier discussion) into the matrix of the larger particles. This change in catalyst structure results in substantial reduction in available surface area but increases in the average diameter of the pores. In contrast, the anhydrous high temperature deactivation (1560 to 1660 F) causes collapse or fusion of small sections of the catalyst structure so that in effect there is a proportional loss or destruction of surface area and pore volume.

With these laboratory findings as a basis it has been possible to establish the relative effects of temperature and steam as the deactivating factors in commercial operations. The major factor influencing catalyst deactivation during commercial operations is the existence of significantly higher local temperatures on the fresh catalyst particles (fresh catalyst addition) during regeneration than indicated by the normal regenerator bed temperature. The extremely high activity of these fresh catalyst particles relative to the main body of catalyst undoubtedly results in a proportionately higher coke deposition during the cracking step. In subsequent regeneration, this abnormally high coke deposit is reflected in extremely high catalyst particle temperatures. Firm evidence substantiating this high local temperature phenomenon was obtained during a study of the catalyst deactivation in a commercial unit. This commercial investigation[42] used a combination of radioactive tracer and catalyst fractionation techniques to follow the history of a fresh catalyst addition to the main inventory. A small batch of tagged (Sc-46 radioactive material) fresh catalyst was added to the main inventory from which samples were withdrawn at periodic intervals. By utilizing a combination of several "sink-float" sedimentation methods it was possible to separate the catalyst into fractions of varying physical properties (i.e., density, pore volume). The distribution of the physical properties of the tagged catalyst was then determined by measuring the radioactivity of the fractions.

From these data it was established that 75% of the surface area and 50% of the pore volume of the fresh catalyst addition were lost in the first day's operation. Based on laboratory studies only a high effective catalyst particle temperature could cause these physical changes in catalyst properties. After the first day's operation, the rate of deactivation of the catalyst particles was much slower and more closely approached the rates associated with the normal temperatures in the unit. During these latter stages of deactivation, the surface area declined at a faster rate than the pore volume, thus indicating that steam partial pressure was playing an important role.

Catalyst contaminants

There are three general classifications of materials which influence the performance of the catalyst if they adsorb on its surface, entering via feed, steam injected into the system or erosion of metal components of the unit. Two of these, alkali metal ions and basic nitrogen compounds, influence the cracking activity by neutralizing the acidity of the surface as mentioned above. The third classification, certain metals or metallic compounds, results in competitive cracking sites having pronounced dehydrogenation-condensation activity.

Iron, nickel, vanadium, and copper exist as trace contaminants in essentially all catalytic cracking feed stocks. The deposition of these contaminants on the catalyst has a pronounced deleterious effect on product distribution. The results of many separate investigations[50,51,52,53,54] show that these metals act as strong sites for dehydrogenation-condensation reactions with resulting increases in coke make and hydrogen production and reduction in gasoline yields. Copper and nickel appear to be about ten times as active as iron with vanadium being intermediate. In order for these metals to be active for dehydrogenation-condensation reactions, they must be present on the catalyst surface. However, as pointed out earlier, the catalyst structure is continually undergoing changes which are exemplified by decreased surface area and pore volume. These changes in catalyst structure result in some of the metallic contaminants being buried under the surface of the catalyst and thus removed as active sites. In general, metal contaminants which are freshly deposited on the catalyst surface are quite active, but as they become more aged it is quite likely that a significant percentage will be buried under the catalyst surface and thus become inactive.

To Be Continued Next Month

Characterization and preparation of . . .

catalytic cracking feed stocks

W. J. SERVICE

W. J. SERVICE is partner in The Pace Co., Houston, process consultants and design engineers, where his main interest is refinery conversion processes such as catalytic cracking and reforming. Service, formerly in the technical service division of Humble Oil & Refining Company's Baytown, Texas, installation, received a PhB from the University of Chicago and BSE and MSE with major in chemical engineering from the University of Michigan. He is special editor for this issue of *Petro/Chem Engineer*.

CATALYTIC CRACKING FEED STOCKS are mixtures of many types of hydrocarbons containing a variety of contaminants. This article reviews briefly:

1. Reactions of the various hydrocarbon types.
2. Status of the knowledge of the composition of petroleum.
3. Effects of the contaminants on cracking operations.
4. Implications of the above as applied to feed stock preparation.

Catalytic cracking of individual hydrocarbons has been studied and discussed extensively. This discussion of the reactions of the various kinds of molecules is based largely on the work of Greensfelder and Voge and their associates.[1,8,32,33]

Each hydrocarbon type, such as the normal paraffins, reacts under catalytic cracking conditions in certain definite ways to give a total product which is very much the same. The major difference between hydrocarbons of a particular type is in their crackability or extent of conversion for a given set of operating conditions. In all cases for one type of molecule, increasing molecular weight increases the crackability.

A variety of reactions take place during catalytic cracking. These include chain rupture, isomerization, cyclization, dehydrogenation, polymerization, hydrogen transfer (from naphthenes to olefins), and condensation. As a result, the products from cracking even a simple molecule such as a normal paraffin are complex.

Normal paraffins crack mostly to propylene, butenes, and butanes and give fair yields of very light gasoline (mostly C_5 and C_6 hydrocarbons). The normal paraffins are fairly difficult to crack. As a result, commercial cycle stocks contain fairly large quantities of normal paraffins. Most of the branching in paraffinic hydrocarbons in petroleum is single (tertiary). There are relatively few quaternary carbons such as found in neopentane or neohexane. Isoparaffins with tertiary carbons crack readily to produce large quantities of propylene, butylenes, and butanes. The gasoline is low boiling and high in octane number.

Naphthenes and isoparaffins tend to crack at about the same rate, but the product distribution is much different. Naphthenes produce relatively little gas and give excellent yields of high octane gasoline. The gasoline is higher boiling than that from paraffin cracking and contains appreciable quantities of aromatics resulting from dehydrogenation of the naphthene rings. Some of the condensed ring naphthenes are dehydrogenated and appear in the product as condensed

ring aromatics. As a result of the high crackability and dehydrogenation reactions, the cycle stock is very aromatic.

Aromatic hydrocarbons crack in several ways. The benzene ring is practically impossible to crack. Condensed ring aromatics without side chains are converted to a limited extent, but almost entirely (75 to 90%) to coke. Alkyl aromatics with side chains containing at least three carbon atoms crack extensively by shearing off the entire side chain. With long side chains, there will be secondary reactions resulting in product distributions like those from cracking of olefins and paraffins. The net result of catalytic cracking aromatic hydrocarbons from petroleum under commercial operating conditions is moderate yields of gas, very little gasoline, large quantities of very aromatic cycle stock, and a high coke yield.

Olefins seldom appear in catalytic cracking feeds except in coker gas oils, but their reactions are of interest since they are the primary products of other cracking reactions. Olefins, heavier than about C_6, are extremely reactive. As a result, catalytic cycle oils (about C_{11} and heavier) contain practically no olefins. The products from olefin cracking are largely propylene, butenes, and butanes. Some polymerization and cyclization takes place in olefin cracking to produce a small amount of cycle stock and fairly high coke yields.

It has been established that cracking of hydrocarbon mixtures usually gives a product distribution which is the same as the sum of that from individual hydrocarbon cracking.[32] The only special effects are the saturation of olefins by hydrogen transfer from naphthenes and the interaction of olefins and aromatics to increase coke formation.[1]

It has been demonstrated[1] that coke when first deposited on the cracking catalyst is mostly highly condensed aromatic ring structures. At least some of the remainder of the coke is strongly adsorbed heterocyclic material such as heavy, basic nitrogen compounds. Thus the aromatic rings present in the feed and those formed by dehydrogenation of naphthenes and cyclization of olefins and paraffins appear to condense and are adsorbed on the catalyst to form the coke.[1,6]

The composition of petroleum

The foregoing discussion of reactions and crackability of the various types of hydrocarbons indicates that it is essential to characterize catalytic cracking feeds as to molecular structure. Once molecular type is established, reliable kinetic relationships can be developed to predict cracking results.

The complete analysis of petroleum for the individual hydrocarbons is a formidable task. API Research Project 6 has been analyzing one representative petroleum for over 30 years.[24] Over 170 individual hydrocarbons have been isolated. This represents about 46% of the total crude, but is probably only a small fraction of the individual hydrocarbons present in the petroleum.

In the heavy gas oil and lubricant fractions (580 to 960 F) of this crude, only the normal paraffins and a couple of aromatic hydrocarbons have been identified. It seems unlikely that all of the individual hydrocarbons, even in this single crude, will be identified. Hence it does not appear feasible to try using a complete hydrocarbon analysis of a catalytic cracking feed stock as input data for correlations or kinetic calculations.

Within the last ten years, mass spectrometric techniques have been developed[9,16] for determining the major compound types in petroleum. These techniques are now providing valuable evidence about crude composition and about the various processes used in treating heavy petroleum fractions.

Mass spectrometry and other evidence is beginning to show us that crude oils are not as complex a mixture of hydrocarbons as had been suspected. Hood, Clerc, and O'Neal recently[11] pointed out that "mass spectral evidence is pointing towards a new and simple picture of relatively few isomeric molecules making up the predominant portion of any hydrocarbon type at any given carbon number or boiling point." This new picture is that the molecules contain one long carbon-atom chain with only a short branch or a ring system at one or both ends. Further, it appears that the rings in one molecule are usually condensed into a single nucleus.

The above evidence gives us some confidence in using

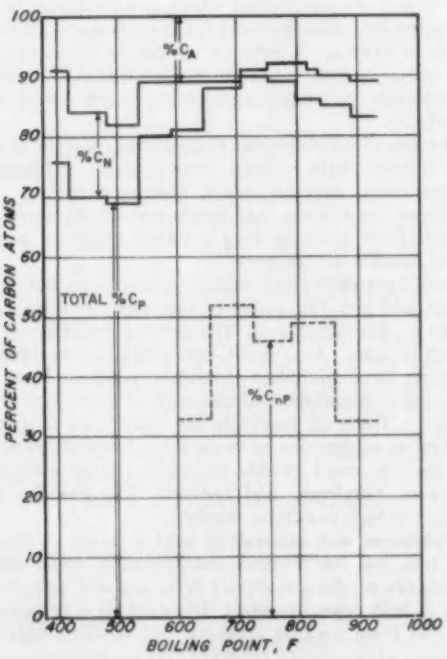


FIG. 1. Carbon-type composition of South Borneo crude.

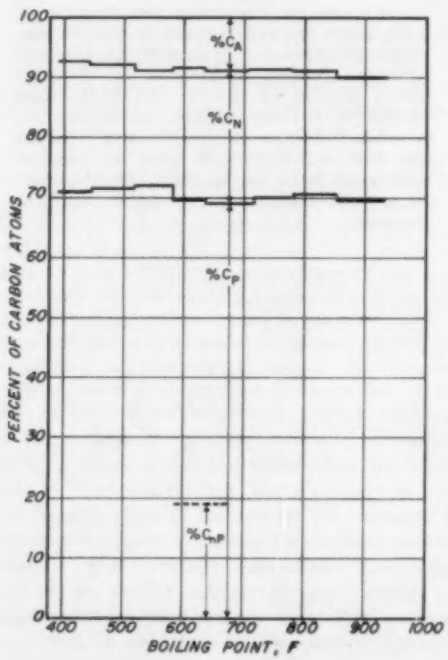


FIG. 2. Carbon-type composition of Pennsylvania crude.

simplified correlations to define hydrocarbon type distribution in catalytic cracking feeds. A number of methods[10,13,14,26,29,34] have been devised which permit estimation of the chemical composition of petroleum fractions using simple tests such as viscosity, molecular weight, density, and refractive index. These various correlations all describe, on a statistical basis, the average composition of an oil in terms of the percentage of the total number of carbon atoms that occur in aromatic (%C_A), naphthenic (% C_N), and acyclic (%C_P) structures.

The various physical property methods for defining carbon-type composition have been evaluated recently by using the properties of petroleum fractions of known composition[28] and properties of synthesized hydrocarbons.[12] The comparisons by Stout[28] showed that each of the correlations gives satisfactory answers for petroleum fractions within the range for which it was developed. The major differences between the correlations are in the range of applicability and ease of utilization. The refractivity intercept-density method[14] is applicable over the widest range of % C_A (up to about 85%). The n-d-M (refractive index-density-molecular weight) method[29] and the refractivity intercept-viscosity-gravity constant (VGC) method[13] are the easiest to use, but are limited to % C_A's below 40 and 50, respectively.

The evaluations of the carbon-type correlations using pure hydrocarbon data[12] gave similar results; i.e., the correlations show satisfactory agreement for most types of hydrocarbons. The inaccurate results for pure compounds with one benzene ring and for those containing non-fused aromatic rings led to the suggestion that these types of molecules do not exist in petroleum in large quantities. Thus, King[12] agrees with the suggestion of Hood[11] that most of the aromatic rings in a petroleum hydrocarbon are condensed into a single nucleus.

The carbon-type composition of a gas oil from a single crude can vary depending on the boiling range. This is shown in Fig. 1 through 4 which have been replotted from Van Ness,[29,30] and show % C_A, % C_N, and % C_P for four gas oils.

Fig. 5 shows the % C_A of a catalytic cracking feed and of the cycle stocks produced from it at two different conversion levels. For this particular gas oil, there was very little variation of aromaticity with boiling point but the cycle stocks produced from it showed considerable variation.

Catalytic cycle stocks are always more aromatic than the feed from which they are produced. There is usually a higher concentration of aromatics in light cycle stocks (500 to 600F) due to the presence of two and three ring aromatics with relatively few side chains. There is always a high % C_A in the higher boiling fractions of cycle stocks because of the condensation of aromatic rings and removal of side chains from the original heavy condensed ring molecules.

Fig. 1-4 also show the amount of normal paraffin (% C_{nP}) in several of the fractions from the four crudes. It is desirable to define the concentration of normal paraffins in a catalytic cracking feed since the crackability of the normal paraffins is much lower than that of branched paraffins. Simple physical measurements such as employed in the estimation of % C_A do not provide a very accurate measure of normal-iso paraffin distribution. Wax content can be used as an approximation of the normal paraffins in virgin distillate stocks.

Nonhydrocarbons and their effect

In addition to hydrocarbons, petroleum contains many molecules having one or more other atoms such as nitrogen, sulfur, oxygen, or one of the heavy metals.

Some nitrogen compounds have an inhibiting affect on the cracking reaction. The inhibition of decalin cracking with added nitrogen compounds is shown in Table 1. This data is from Voge, Good, and Greensfelder.[32] Mills, Boedeker, and Oblad[19] report similar information.

There appears to be no doubt that the temporary poisoning effect of nitrogen compounds is due to neutralization of the active, acidic sites on the catalyst.

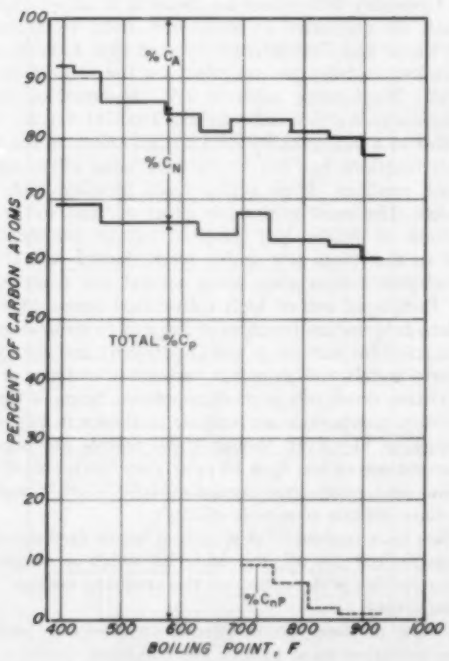


FIG. 3. Carbon-type composition of Middle East Crude.

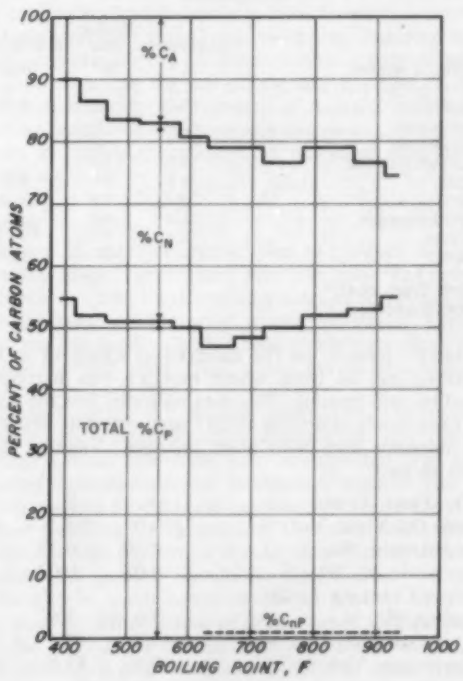


FIG. 4. Carbon-type composition of Maracaibo crude.

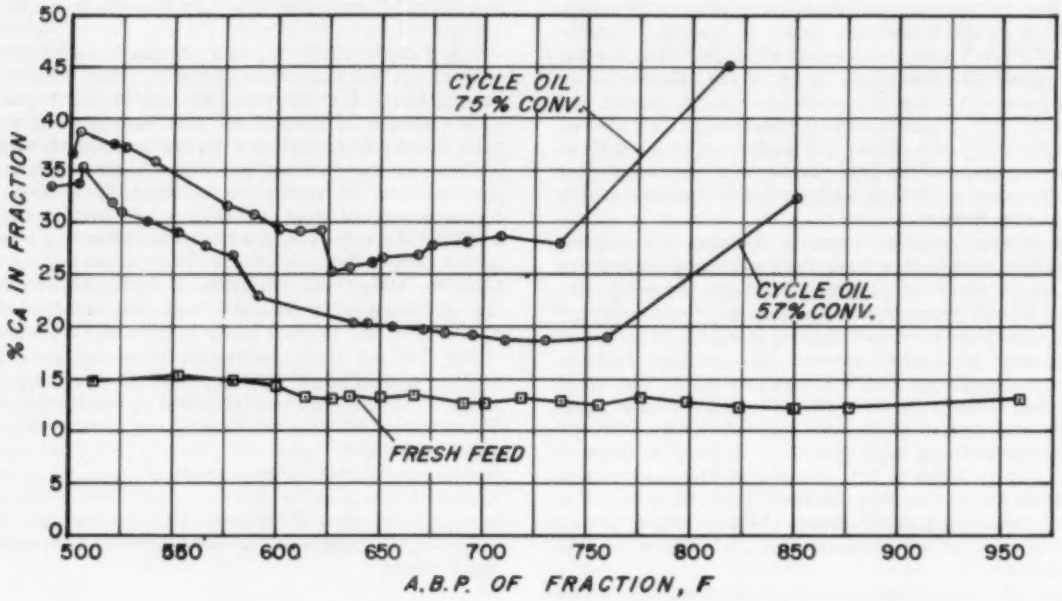


FIG. 5. Aromaticity of fresh feed and cycle stocks.

Richter, et al,[23] define basicity of nitrogen compounds which may exist in petroleum. They present a table listing some of these compounds in order of basic strength. Values for those compounds tested by Voge are shown in Table 1 where pKa is the negative logarithm of the ionization constant of the conjugate acid of the base in question. Thus, as pKa's increase, an increase in basic strength is indicated. There is no apparent relationship between the inhibition effect and the basic strength of the various compounds.

TABLE 1. Inhibition of Decalin Cracking by Nitrogen Compounds.

Compound Added	Conversion %*	Inhibition %*	Base Strength pKa**
None	41.9	.....	.....
Ammonia	42.0	0	9.27
Methylamine	42.0	0	.....
Diamylamine	42.3	0	.....
Dicyclohexylamine	28.0	33	.....
Pyridine	26.8	36	5.23
Indole	25.1	40	ca. 0.0
x-Naphthylamine	21.8	48	.....
Quinoline	8.5	80	4.94
Acridine	8.2	81	5.60

*From Voge, et al[32]
**From Richter, et al[23]

Viland[31] reports on the catalytic cracking of a heavy California gas oil from which nitrogen was partially removed by acid treating. This data indicates that the conversion (and hence inhibiting effect) may correlate better with total nitrogen than with basic nitrogen. Viland's data is shown in part:

H_2SO_4 Treat, lb/bbl	0	2	4
Treated Oil Yield, Vol. %	100.0	98.4	96.9
Total Nitrogen, Wt. %	0.30	0.23	0.17
Basic Nitrogen, Wt. %	0.08	0.02	0.01
Catalytic Cracking Yields			
Carbon, Wt. %	5.0	5.0	5.0
C_4 + Gasoline, Vol. %	44.4	47.2	52.5
Conversion, Vol. %	49.8	53.0	58.4

Plank and Nace[22] suggest that the basicity of nitrogen compounds may vary widely at cracking conditions from that measured at low temperatures in a laboratory. Ball, Latham, and Helm[2] offer an hypothesis that the basic to total nitrogen ratio changes during processing because of removal of low molecular weight sulfur compounds from basic centers of the heavy nitrogen compounds.

It appears that neither basic nor total nitrogen by itself is a satisfactory measure of cracking inhibition. It is probably necessary to use either basic or total nitrogen and an adsorption coefficient which might be a function of molecular weight to predict the inhibiting effect of a petroleum stock on a catalytic cracking operation.

Oxygen compounds like those which may occur in petroleum have very little effect on catalytic cracking. Aliphatic alcohols are converted to water and olefin when cracked. Voge, Good and Greensfelder[32] report that addition of 1% m-cresol to decalin had no effect on the rate of cracking at 500C. Naphthenic acids in 1% concentration reduced the decalin conversion only slightly, from 41.9% to 38.3%.

Sulfur in a cat cracking feed has no effect on the hydrocarbon reactions but has a relatively large effect on some product qualities. High sulfur feeds produce high sulfur products. The most noticeable effect of feed sulfur is the reduction in leaded cat gasoline octane numbers compared to that from low sulfur feeds. Sulfur will alter the product distribution when using natural clay cracking catalysts. Prolonged use of high sulfur feed seems to activate the dehydrogenation function of the iron in natural catalysts with a resultant increase in gas (hydrogen) and coke yield.[18]

Heavy metals such as nickel, vanadium, and iron are present in many crude oils in small quantities. Some of the metal containing compounds are volatile as shown in Fig. 6 from Dunning, et al.[5] Even though these metals are present in concentrations of less than 10 ppm, they can increase hydrogen and coke production considerably[3, 4, 5, 7, 18, 25] and therefore, have serious economic effects.

It has been reported[20] that in very heavy feed stocks such as deasphalted gas oil, the material which is measured as carbon residue is deposited on the cracking catalyst almost quantitatively.

In view of these above effects, an adequate feed stock characterization must include the following qualities:

1. Carbon-type composition (% C_A, % C_N), both averages and distribution with boiling point.

2. A complete distillation.
3. Average boiling point or molecular weight.
4. Normal paraffin content.
5. Nitrogen content (basic and/or total).
6. Sulfur concentration.
7. Bromine number or olefin content.
8. Metals content.
9. Carbon residue.

Feed preparation processes

Refining economics usually dictate that the conversion processes should be operated at maximum capacity. For catalytic cracking, this means maximizing feed rate and conversion. These two variables are interrelated and sometimes one may be increased at the expense of the other, as during the winter it may be desirable to remove light virgin gas oil from the feed and increase conversion on the remaining feed stocks. In cases where additional reasonable quality feeds can be recovered, they should be cracked even though conversion is reduced.

In general, then, the catalytic cracking feed preparation processes should be used to recover the maximum quantity of the best quality feed stock. The major processes which recover additional feed from crude are distillation, coking and deasphalting. Residuum hydrocracking is another process in the same category but to date it has not proved economical. Processes designed to improve the quality of the catalytic cracking feeds are distillation of cycle stock, liquid-liquid extraction of virgin feeds and cycle stocks, and hydrotreating. Each of these processes is discussed briefly in the following paragraphs with particular emphasis on optimum ways to operate the processes and the advantages of each.

Crude distillation

Atmospheric distillation of crude has been used for many years to recover feeds for thermal and catalytic cracking.

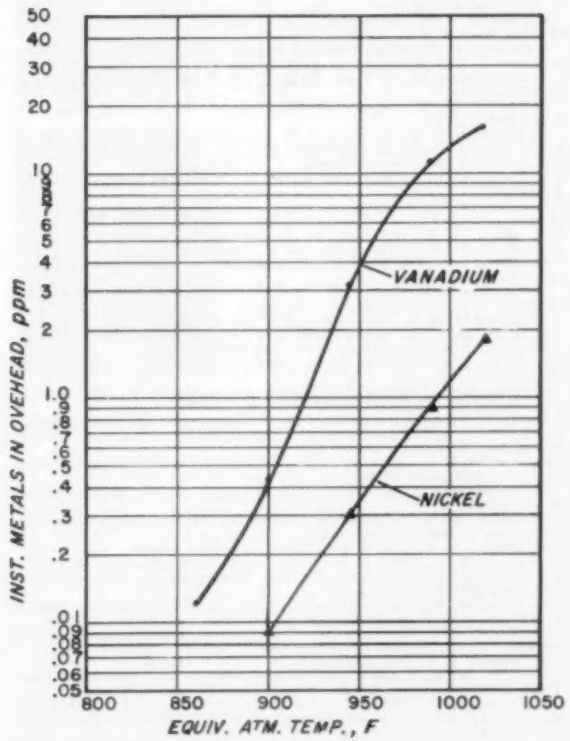


FIG. 6. Volatility of metals in Bachaquero crude.

Generally, a light gas oil and a heavy gas oil are recovered as sidestreams from the atmospheric tower of a crude unit.

Heavy gas oil is nearly always charged to catalytic cracking. It is usually desirable to maximize recovery of the heavy gas oil by operating with maximum furnace outlet temperatures. In some cases, however, the tower may be undersized and entrainment of reduced crude into the heavy gas oil can result in serious catalyst contamination. In such cases installation of a wire mesh screen between the flash zone and the heavy gas oil withdrawal plate has eliminated the problem. A small wash stream over several bubble cap trays below the withdrawal tray will also reduce the entrainment problem.

The light gas oil stream may be directed either to catalytic cracking or to diesel fuel oil or heating oil sales. It is usually a good cat cracking feed. Since it is lower boiling than most other feeds, more severe cracking conditions are required for a given conversion of the light gas oil. If more than one cracking unit is used, it can be desirable to segregate the light feeds to one unit where the optimum cracking intensity can be maintained.

When the light gas oil is being cracked catalytically, the front end should be well fractionated so there is no gasoline boiling range material remaining. The virgin gasoline is very low in octane number and is largely unconverted in the cracking operation. The net result of leaving gasoline in cat cracking feed is to produce a lower octane number catalytic gasoline.

Most refiners are now using vacuum distillation to recover additional cat cracking feed from reduced crude. It is desirable to recover the maximum amount of vacuum gas oil from the residuum since this means elevating the gas oil from No. 6 fuel oil worth perhaps $2 per bbl to cat cracking feed worth $3.50 to $4 bbl. Maximum gas oil recovery is attained by operating at minimum pressure and maximum temperature.

Under very severe flashing conditions some of the volatile, metal containing molecules will be distilled out of the residuum and can cause serious catalyst contamination when the gas oil is cracked. The effect of this kind of contamination can be reduced by more precise fractionation between the heavy vacuum gas oil and residuum. Pumping a small reflux stream over one or more bubble cap trays between the flash zone and the gas oil drawoff has been very successful in reducing the amount of volatile metals in cat cracking feeds. Wire mesh screens are used in many vacuum towers to reduce the amount of residuum entrained into the gas oil.

Coking

Coking of crude residua is used to produce light gases, a gasoline stock, cat cracking feed and coke. The coker gas oil is not as good a cat cracking feed as the virgin gas oil from the same crude since it is more aromatic. Therefore, coker gas oils produce higher coke yields than virgin stocks. Despite the high coke yield, coker gas oil is a reasonably good cat cracking feed.

Delayed coking is a process wherein the residuum feed is heated to a relatively high temperature and then goes through a drum where the coke is deposited. The coke is removed intermittently by mechanical means. The lower boiling cracked products are separated and recovered in subsequent fractionation operations. The same precautions observed in crude distillation should be used in a coker fractionator. All gasoline should be separated out of the gas oil since it too would lower the octane number of the catalytic gasoline. Entrainment of unconverted residual material into the gas oil can contaminate it with metals and other coke producing materials. Entrainment in coker fractionators usually is controlled by refluxing over various contacting devices.

In the fluid coking process, the residuum feed contacts hot fluidized coke particles on which the coke deposits. The contact time is less and operating temperature higher than in the delayed coking process. This results in lower yields of gas, gasoline and coke and higher gas oil yields. Contamination should be kept to a minimum by the proper use of appropriate contacting devices.

Deasphalting

Propane or propane-butane mixtures are used to precipitate asphalt from virgin residuum. The deasphalted gas oil (DAGO) is a relatively good catalytic cracking feed. It does contain appreciable amounts of carbon residue and heavy metals. Deasphalting units should be operated as close as possible to the point where the next increment of DAGO is worth no more in cat cracking than in fuel oil because of contamination with metals and/or carbon residue.

DAGO yield should be maximized by keeping the solvent circulation rate at its maximum. Increasing the molecular weight of the solvent by addition of butane will increase DAGO yields but also increases the contamination. The residuum feed to a deasphalting operation should be vacuum flashed as deeply as possible since this improves the overall yield-quality relationship of the total cat cracking feed.[17]

A new process was announced recently in which the heavy polymer from catalytic cycle stocks or from thermal cracking of cycle stocks is used as a selective absorbent for removing the heavy metals from DAGO.[15,17] This so-called wash oil operation permits sizeable increases in DAGO yield without additional contamination.

Cycle stock fractionation

Since the concentration of aromatics, which are the major coke formers, varies throughout the cycle stock boiling range, fractionation can be used to remove some aromatics from the stocks which are recycled to the reactor. The worst material in the cycle stock, from a coke producing standpoint, is the high boiling polymer. As shown in Fig. 5, the material boiling above about 800F is highly aromatic. Proper operation of the cat cracking unit fractionator can eliminate most of the polymer from the recycle while losing as little good quality cycle oil as possible. This should be done by keeping the fractionator bottoms temperature as high as possible and by operating the settler to produce as little slurry as possible. The decanted or clarified oil should not be returned to the reactor.

Because the separation in most cat cracking fractionators is not very precise (especially if the unit has been greatly expanded) a large amount of good quality cycle stock may be left in the decanted oil. In some cases it is economically attractive to add a re-distillation operation to make a sharper separation between good cycle stock and polymer.[17] Fractionation is a highly selective process for removing the heavy aromatics because of the extremely non-ideal vapor-liquid equilibria relationships.

Liquid-liquid extraction

Liquid-liquid extraction using such solvents as furfural, phenol or sulfur dioxide can be an effective means of improving the quality of cat cracking feeds. These solvents remove the aromatic, coke-forming materials. The aromatics in virgin feeds have good quality paraffinic and naphthenic sidechains so that some good feed material would be discarded in the extract from a virgin feed treating operation. These solvents are very selective for the heavy metal compounds so that fresh feed extraction may be justified on the basis of reducing catalyst contamination.

Extraction of catalytic cycle stocks removes only aromatic compounds from which the good quality sidechains have been largely removed. Cycle stock extraction is, therefore, more selective in discarding the coke formers. In the case of either feed stock, by combining the extraction operation with a lube extraction process, substantial capital savings can be effected. The combination operation involves the use of the lube extract solution as the solvent for the cat cracking feed operation.[21]

Hydrotreating

Hydrotreating of cat cracking feeds has several beneficial effects. The sulfur content of the feed is appreciably reduced resulting in lower sulfur and more stable light cycle oil. The catalytic gasoline is also lower in sulfur and hence the TEL susceptibility is improved. The leaded octane number may be increased by more than 2.0.

Hydrotreating removes most of the heavy metals from a virgin gas oil. The reduced contamination reduces coke yields (or permits higher conversion) and hydrogen yields. Reduced hydrogen production can be especially attractive if ethylene is being recovered from the cat cracking tail gases since this reduction increases ethylene recovery.

A large reduction in carbon residue results from hydrotreating. Even when using fairly mild conditions, some aromatic rings are hydrogenated to naphthenes and this further reduces the coke forming tendencies of the gas oil. Other less important advantages may come from the small volume gain on hydrotreating and from the increased production of hydrogen sulfide which, if it is recovered, can give additional revenue while reducing air pollution.

Hydrotreating of catalytic cycle stocks can reduce the aromatic ring content but would not reduce the product sulfur content as much as treating the virgin feed and would have no effect on catalyst contamination.

References

1. Appleby, W. G., Gibson, J. W., Good, G. M., *Preprints of ACS, Div of Petrol. Chem.*, 5, No. 4-B, B-71 (1960).
2. Ball, J. S., Latham, D. R., Helm, R. V., *J. Chem. & Eng. Data*, 4, 167 (1959).
3. Donaldson, R. E., Rice, T., Murphy, J. R., *Preprints of ACS Div. of Pet. Chem.*, 5, No. 4-B, B-97 (1960).
4. Duffy, B. J., Hart, H. M., *Chem. Eng. Prog.*, 48, 344 (1952).
5. Dunning, H. N., Moore, J. W., Bieber, H., Williams, R. B., *Preprints of ACS, Div. of Pet. Chem.*, 5, No. 1, 169 (1960).
6. Gladrow, E. M., Kimberlin, C. N., *Preprints of ACS, Div. of Petrol. Chem.* 5, No. 4-B, B-61 (1960).
7. Gossett, E. C., "The Effect of Catalyst Metal Poisoning on Fluid Cracking Yields" presented to AIChE, San Francisco, Dec., 1959.
8. Greensfelder, B. S., Voge, H. H., Good, G. M., *Ind. & Eng. Chem.*, 41, 2573 (1949).
9. Hastings, S. H., Johnson, B. H., Lumpkin, H. E., *Anal. Chem.*, 28, 1243 (1956).
10. Hastings, S. H., Johnson, B. H., Lumpkin, H. E., Williams, R. B., ASTM Special Technical Publication No. 224, *Symposium on Composition of Petroleum Oils*, 250, (1958).
11. Hood, A., Clerc, R. J., O'Neal, M. J., *J. Institute of Petroleum*, 45, 168 (1959).
12. King, R. W., Kust, M. A., Kurtz, S. S., Jr., *Anal. Chem.*, 32, 738 (1960).
13. Kurtz, S. S., Jr., King, R. W., Stout, W. J., Partikian, D. G., Skrabek, E. A., *Anal. Chem.*, 28, 1928 (1956).
14. Kurtz, S. S. Jr., King, R. W., Stout, W. J., Peterkin, M. E., *Anal. Chem*, 30, 1224 (1958).
15. Lawson, J. E., Peet, J. P., Peet, N. P., *Pet. Refiner*, 38, No. 3 177 (1959).
16. Lumpkin, H. E., *Anal. Chem.*, 28, 1946 (1956).
17. McMillan, K. K., *Oil & Gas Journal*, 58, No. 6, 89 (1960).
18. Mills, G. A., *Ind. & Eng. Chem.*, 42, 182 (1950).
19. Mills, G. A., Boedeker, E. R., Oblad, A. G., *J. Am. Chem. Soc.*, 72, 1554 (1950).
20. Oden, E. C., Granberry, T. S., *Ind. & Eng. Chem.*, 44, 806 (1952).
21. Payne, G. L., U. S. Patent 2,748,055 (1956).
22. Plank, C. J., Nace, D. M., *Ind. & Eng. Chem.*, 47, 2374 (1955).
23. Richter, F. P., Caesar, P. D., Meisel, S. L., Offenhauser, R. D., *Ind. & Eng. Chem.*, 44, 2601 (1952).
24. Rossini, F. D., Mair, B. J., *Proc. Fifth World Petroleum Congress*, New York, Section V (1959).
25. Rothrock, J. J., Birkhimer, E. R., Leum, L. N., *Ind. & Eng. Chem.*, 49, 272 (1957).
26. Smith, E. E., *Engineering Experiment Station Bulletin No. 152*, Ohio State University, May, 1953.
27. Sterba, M. J., *Ind. & Eng. Chem.*, 41, 2680 (1949).
28. Stout, W. G., King, R. W., Peterkin, M. E., Kurtz, S. S. Jr., ASTM Special Technical Publication No. 224, *Symposium on Composition of Petroleum Oils*, 230 (1958).
29. Van Nes, K., and Van Westen, H. A., *Aspects of the Constitution of Mineral Oils*, Elsevier Publishing Company, Amsterdam (1951).
30. Van Nes, K., Chap. 18 from *The Chemistry of Petroleum Hydrocarbons*, Vol. 1, Reinhold Publishing Corp., New York (1954).
31. Viland, C. K., *Pet. Refiner*, 37, No. 3, 197 (1958).
32. Voge, H. H., Good, G. M., Greensfelder, B. S., *Proceedings Third World Petroleum Congress*, The Hague, Sect. IV, 124 (1951).
33. Voge, H. H., Chapter on Catalytic Cracking, *Catalysis, Vol. VI*, pp. 407-493, edited by P. H. Emmett, Reinhold Publishing Corp., New York (1958).
34. Waterman, H. I., *Correlation Between Physical Constants and Chemical Structures*, Elsevier Publishing Co., Amsterdam (1958). ★ ★

WILLIAM C. CHATMAN
Senior Process Engineer
Foster Wheeler Corporation
New York

CHIA WEI CHEN
Senior Process Engineer
Foster Wheeler Corporation
New York

GEORGE T. ATKINS
Consulting Engineer for
Foster Wheeler Corporation
Baytown, Texas

catalytic cracking process design

IN CATALYTIC CRACKING the choice, by a large majority, has been for one or another of the familiar licensed fluid processes designed and erected in accordance with a technology developed over a period of many years. While smaller units still find their place according to the local circumstances, the well known sizes of the large new ones recently built or now under construction tell the story of the reliability of present day design. It is not to any one detail or characteristic that this progress is due, but to the favorable groupings of the best experience into the modern designs as they are now offered to the refining industry. But there is so much latitude here for an exposition of this broad field that all that can be done is to express from one point the nature of the considerations which process design must take into account in the present day.

Feed stocks, conversion and yields

The modern fluid catalytic cracking unit is indeed the workhorse of the refinery in that it is capable of charging many different feed stocks to produce a substantial base component for the refinery gasoline pool. It is not uncommon for a particular refinery to crack atmospheric and vacuum gas oil from two or three different crudes, as well as coker gas oil and cycle stock, in one or more cracking units. The question naturally arises, *Where does the process designer obtain the yield structure for these different charging stocks, and how does he blend these yield structures into the overall cracking operation?* The steps involved represent not only current activity as for each proposal, but also

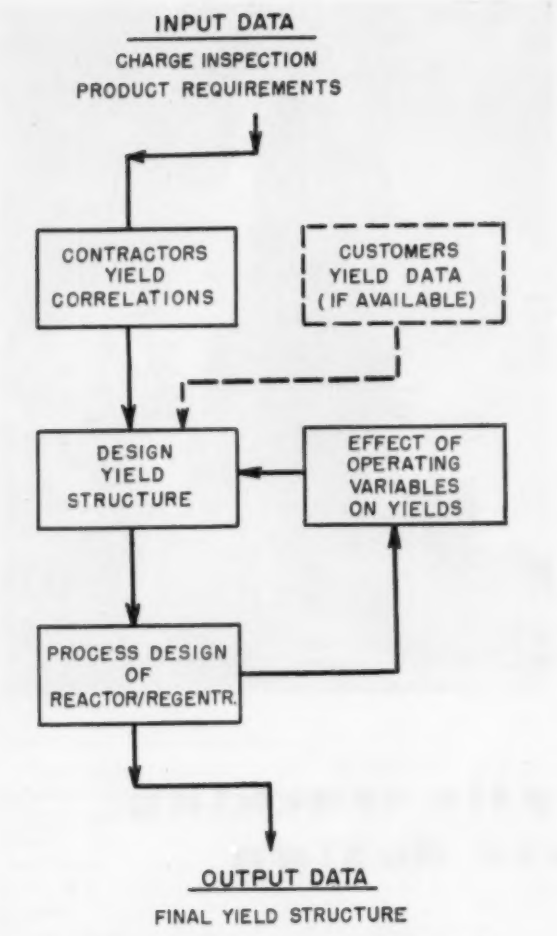


FIG. 1. Steps in design of reactor/regenerator.

the accumulated experience of the organization and of the industry. They are indicated in Fig. 1.

The refinery usually has its particular feed stock quality well defined before beginning design work on a contemplated cracking unit. Particular yield structures for similar operations and for other operating conditions are also available under certain circumstances. The designer takes these data, and from yield correlations based on operating data in his possession, establishes a basic yield structure. Using this basic yield structure, he then establishes a preliminary reactor design and conditions of operation such as catalyst-to-oil ratio, reactor temperature and pressure, space velocity, recycle ratio, etc. The basic yield structure is then adjusted for the effect of these operating variables and a refined yield structure and process design is established. This process is continued until a final consistent set of yields, operating conditions and reactor design is established which meets the refiner's requirements and which also is based upon past successful experience.

Of the many criteria which are considered in going through the procedures outlined above, three of the most important are reactor temperature, catalyst-to-oil ratio, and recycle ratio, since these factors have a predominant influence on the major consideration, namely, gasoline-to-coke ratio. It is obviously in the best interest to obtain as high a gasoline-to-coke ratio as possible; noting, however, that in the most usual case, i.e., not including a fired heater, the coke production also of necessity must be such as to satisfy the heat balance requirements of the system. As a particular instance, the gasoline yield for once-through cracking of, for example, Arabian gas oil increases with conversion to a maximum yield at 45 to 55% conversion, and thereafter starts to drop. Simultaneously, the coke yield increases very slowly at first, but then increases more and more rapidly with conversion. It is also well known that cycle stock cracking produces less gasoline and more coke than virgin gas oil cracking at the same conversion. In spite of this, however, at high overall conversion levels, cycle stock is cracked in the reactor in order to keep the fresh feed conversion per pass low enough to effect a high gasoline-to-coke ratio. In addition to having an important effect on the gasoline-to-coke ratio, the cycle stock also acts as a heat carrier, transferring the heat of combustion of the coke from hot catalyst to the main fractionator. Accordingly, a cracking temperature must be selected which will not only yield a high gasoline-to-coke ratio, but will also produce sufficient coke for heat balance. It should be noted that the effect of temperature on coke production is modified somewhat by the catalyst-to-oil ratio, since the high catalyst-to-oil ratio at increased temperatures tends to increase coke production. The catalyst-to-oil ratio hence is always a most important item to watch and, as will be explained later, is basic in the design of transport reactor systems.

It is readily apparent that different types of cracking stocks require different cracking conditions in order to achieve the optimum in gasoline-to-coke ratio. Many times this consideration is ignored by processors, simply because the economics do not warrant the installation of two or three cracking units, each one charging different feed stocks. A distinct trend has been noted, however, in large integrated refineries with two or more cracking units, in that segregated charge stocks are fed to the different units. For example, one unit may be used to charge atmospheric gas oil, a second used for vacuum gas oil, and a third for cycle stock and coker gas oil. In this way the operator avails himself of the optimum cracking conditions for each particular charge stock.

Dense phase reactor design

Having established basic yield data and operating conditions, the design engineer then translates these into the design of the reactor proper, all in the manner that best fulfills the essential principle of the process. It is no secret that this phase of the design is all-important, indeed the very heart of the matter; for if good yields are to be obtained, they must be obtained here. Two of the main considerations in establishing this design are the injection of the feed (fresh and recycle) in the catalyst, and the distribution of the feed and catalyst mix into the reactor proper.

In the ordinary cracking unit, regenerated catalyst flows down through a standpipe and slide valve and experiences a sharp change in direction, flowing into either an inclined or vertical riser, depending on the design. Fig. 2 indicates the two different methods of oil riser design. For the inclined riser, shown in Fig. 2a, refractory material is filled into the bottom section of the riser and shaped in such a way as to prevent any dead spot. For the vertical riser design, shown in Fig. 2b, the catalyst is maintained in a fluid state at the bottom of the riser by the injection of steam. An oil and steam mixture is then injected into the catalyst through atomizing nozzles which provide intimate mixing of oil and catalyst at an elevation which is just high enough to prevent backflow of oil vapor into the regenerated catalyst standpipe. The riser then carries the oil and catalyst mixture into the reactor. The selection of proper riser diam-

eter is most important. If the riser is sized too large, catalyst moves very slowly; oil vapors tend to channel with the possibility of overcracking; and high pressure drop results because of the high density of the poorly fluidized bed. If sized too small, it is possible that an undesired limitation will be placed on the catalyst circulation.

In the top of the riser, the mixture is fed through a grid which distributes it throughout the reactor cross-section and insures minimum channeling and dead spots. Again, grid design is most important in that it must have a pressure drop through the grid hole high enough for distribution while yet not so high as to cause erosion; it must be sealed at its edges to prevent backflow of catalyst; and its mechanical design must provide both support and flexibility.

Once good feeding and good distribution is assured, the reactor chamber must be designed to eliminate dead spots where the oil and catalyst mixture can stew and form a dense mass of coke and catalyst. Enough bed height must be provided for the proper space velocity, and the outage and bed velocity carefully chosen to prevent excessive entrainment with consequent cyclone overloading. The cyclone dip legs must be sized properly and be long enough to insure catalyst return. Finally, the plenum chamber and overhead line must be sized large enough to avoid excessive pressure drop between the reactor and fractionator.

Transport reactors

It is generally recognized throughout the industry that a large amount of cracking takes place in the reactor riser, in spite of the low residence time there. As a matter of fact, the early upflow war-time units used this principle and accomplished all the reaction in a riser (transport) reactor. At that time, however, it was not customary to use any recycle, and control of overall conversion and heat balance was rather difficult with this type of system, which was one of the main reasons for going to a fluid bed type of reactor where the conversion could be changed by varying the bed level. Theoretical considerations (e.g., elimination of backmixing, obtaining a high degree of contact between oil and catalyst, etc.), however, indicate that a transport reactor should offer better yields than a fluid bed reactor. It is also a fact that at least two large refineries now have cracking units which employ transport reactors, while a number of other refiners are operating their conventional units with riser cracking only, in a fashion similar to a transport reactor.

Transport reactors present a number of problems to the design engineer, chiefly because design data are hard to obtain owing to the newness of these units. For example, although it is generally recognized that transport systems will result in better yield structures than conventional units, the designer is often forced to base yield structures on data obtained from conventional units, since incremental improvements are not precisely known. Also the selection of proper space velocity is very difficult. Often, for this reason, a particular designer may try to "hedge his bets" by making provision for a bed on top of the transport reactor although he recognizes that by so doing he may sacrifice any improved yield benefits.

Once having selected the proper space velocity and range of superficial velocities, the design engineer is then faced with a complex reactor design involving trial and error heat, material, conversion and pressure balances for each section of the transport reactor. Fortunately this type of computation lends itself readily to computer application and, by selection of a proper program, a complete reactor design ordinarily taking perhaps 4 to 5 days, can be done in something under 10 minutes of computer time.

With a computer program for reactor design established, the designer has then also a valuable tool for checking the performance of a particular design with respect to changes in each of the variables. When results are compared, it is found that the transport reactor offers at least as much flexibility to the refiner, conversion being the variable, as does a conventional unit in which space velocity is made a function of the bed depth. For example, to increase conversion in a transport reactor, the temperature is raised somewhat, thus increasing the catalyst-to-oil ratio, and increasing the holdup in the reactor. It is found that because of these other simultaneous changes, a substantial increase in conversion

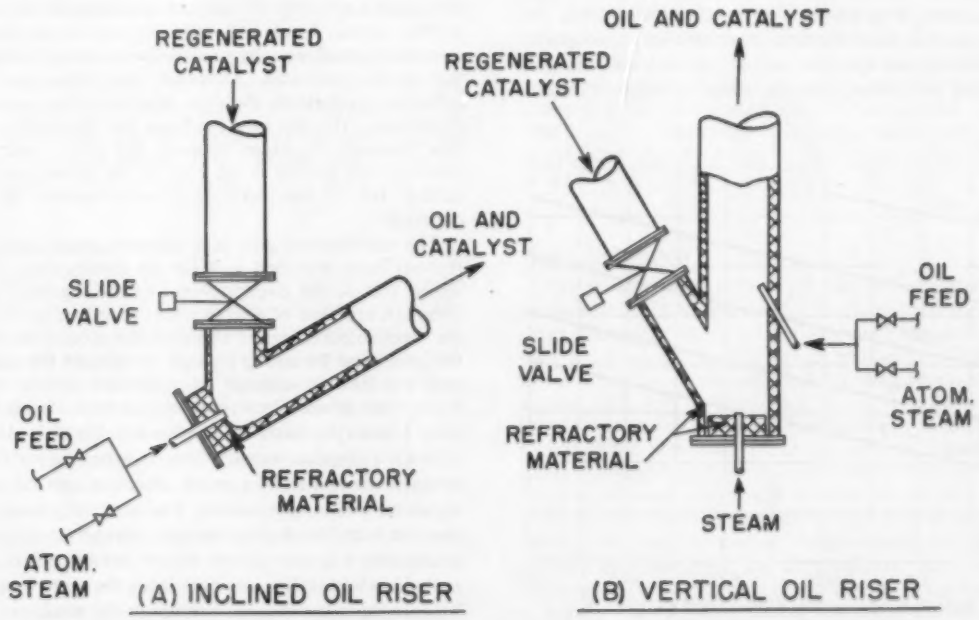


FIG. 2. Design of oil riser.

may be obtained by a relatively minor change in temperature. As in conventional units, the recycle rate is varied to maintain the unit in heat balance, although this also may be used, to a certain extent, to change conversion.

The above is not surprising, considering that many refineries with conventional units consider varying bed level to be a poor way of changing conversion, and instead prefer to adjust the cracking temperature and recycle rate, holding the bed level constant.

In summary, it may be stated that although transport reactors are relatively new, there are no insuperable design problems associated with them, while they now offer the best prospect for improved yield structures and increased efficiency for the modern catalytic cracking unit.

Multiple reactor systems

As was mentioned before, many refiners tend to shy away from multiple reactor systems because their cracking capacity is too small to justify more than one catalytic cracking unit. With the advent of the transport reactor, however, the way is opened for even the small refiner to enjoy the advantages of cracking feed stocks with widely differing characteristics at their respective optimum cracking conditions. Consider, for example, a single regenerator with multiple standpipes, each one going to a different transfer line reactor with the overhead lines from these reactors going to a common cyclone chamber. Such a system could have almost as low a capital investment as a single conventional unit, but would still allow the refiner to operate the transfer lines under widely varying conditions. In addition, a unit of this type could offer even greater flexibility than two or three conventional units operating with segregated charge stocks, in that since all reactors share a common regenerator, each reactor could be operated out of heat balance as far as its individual coke production is concerned, as long as the overall heat balance is satisfied. Also, since the regenerator acts as a common reservoir of regenerated catalyst, each reactor can take as much or as little catalyst as it requires for its particular conversion level.

Systems of this type have been investigated using the transport reactor computer program described above, with some very interesting results. In one particular case, for example, two transport reactors were studied, one operating on fresh feed and the other on recycle feed. One variable was changed at a time, and the effect of many variables such as regenerator pressure, feed preheat, etc., was determined in addition to the effect of reactor temperature. Some of the results of this study are shown in Fig. 3, which plots the overall conversion on fresh feed as a function of recycle feed cracking temperature, with parameters of fresh feed cracking temperature. It is readily seen that without resorting to artificial means of changing the reactor space velocity (such as the introduction of inert gas or steam), the overall fresh feed conversion level can be varied from 50 to 80 plus. Furthermore, at any particular overall conversion level, the once-through fresh feed and recycle feed conversions can be varied within wide limits, thus permitting the refiner to determine his own optimum fresh feed and recycle feed cracking conditions to obtain a given total conversion. The recycle ratio for this example was maintained between 80 and 100 vol. % and the unit was maintained in overall heat balance. Within this range of conversion, the pressure drop on spent and regenerated catalyst slide valves varied approximately 4 psi, which is well within a good design range.

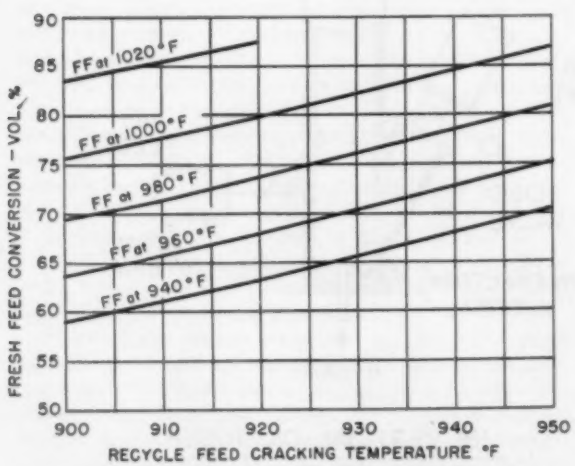


FIG. 3. Variation of conversion with recycle cracking temperature.

It is interesting to note that even more flexibility can be obtained if other modes of operation are considered. For example, regenerator temperature can be varied somewhat, thus affecting catalyst circulation, catalyst-to-oil ratio and, ultimately, space velocity; inert gas can be cycled through either of the transport reactors for the purpose of changing space velocity; and in periods of low demand, one reactor can be shut off entirely, maintaining a small amount of steam in order to prevent backflow of catalyst.

Regenerator

If the reactor is considered to be the heart of the cracking unit, the regenerator is certainly the lungs, because it is here that the catalyst is cleansed of its coke and made fresh for further use. Also, because of the large amount of heat released by the burning coke, the regenerator is the prime energy source for both the cracking and vapor recovery units.

Perhaps the most important single item in the design of the regenerator is the distribution of combustion air through the catalyst bed. The two principal methods of obtaining distribution are by providing either a pipe distributor or a distribution grid. The pipe distributor utilizes several radial pipe spokes to carry the air to a vast number of concentric piping arcs. Each of the piping arcs contains a number of small, equally spaced slots or holes through which the air is distributed. Although reasonably good air distribution is obtained, the pipe distributor has two principal drawbacks. The first is a tendency for the catalyst to backflow through the areas between the pipes, with resulting erosion. The second is the cost of the numerous welds required for a complete distributor system of uniform coverage.

The distribution grid is a concave steel plate with numerous holes punched in it for air distribution. The grid is sealed around the circumference of the regenerator. Again, although this type of grid provides excellent air distribution, the mechanical design of this member is quite involved since the grid must be strong enough to support the catalyst bed and yet flexible enough to withstand severe expansion. Even after severe abuse, however, a well-designed grid has been known to continue to give excellent air distribution.

Some refineries consider true countercurrent flow of air to spent catalyst to be a prime objective, and favor a design in which this is approached. The idea, of course, is to see that air with the highest oxygen content contacts regenerated catalyst, so the carbon will be burned off to a low percentage, while at the same time using the air to best efficiency by going to a low oxygen content in the stack gas. It should be pointed out that this countercurrent flow is exactly the

reverse of good reactor design criteria, where everything possible is done to eliminate back-mixing and to establish cocurrent flow of oil feed with the freshly regenerated catalyst.

One of the prime concerns of the design engineer is the elimination of afterburning. It is generally recognized that afterburning in the dilute phase is initiated at one or more points where the local oxygen content of the flue gas is higher than average. Therefore, with good air distribution and proper flow of air relative to catalyst, the primary concern in the regenerator design is to eliminate dead spots in the bed so that the air entering the dilute phase at any particular point does not have too high an oxygen content. Once severe afterburning starts, it is rather difficult to control. Each refinery, however, has developed its own techniques for bringing the system back to normal. These include injection of spray water to remove heat; decreasing the output of the main air blower; increasing charge rate and/or conversion (thus increasing coke-make, which tends to decrease the oxygen in the flue gas); and injection of torch oil (which again tends to decrease the oxygen in the flue gas). It should be noted that operating measures taken to stop afterburning tend to induce carbon buildup on the catalyst, and vicious cycles can result. For this reason, it is generally agreed the best way to control afterburning is preventative; i.e., to have a well-designed regenerator such as to keep the oxygen content of the flue gas to a practical minimum.

At the present time, considerable studies are being made with an eye to improving regenerator design. Two possibilities which show promise are:

- **increasing the contact efficiency between air and catalyst**
- **increasing the regenerator temperature to obtain higher specific burning rates.**

One of the ways of improving contact efficiency is to design for higher dense bed velocities, so that regenerator operation approaches the ideal of a true countercurrent transport system. In this regard, many refiners have noticed that as they increase the coke-burning capacity of the regenerator beyond the design point, they do, in fact, obtain better specific burning ratios.

The main drawbacks to increasing regenerator temperatures are material selection and control of afterburning. At the present time, however, many refineries have at least partially solved these problems and it is to be expected that a few years hence, regenerators will be designed to operate at temperatures up to 1200F in the dense phase.

Pressure balance

The pressure balance for a particular design determines the operating regenerator pressure and the selection of the air blower. This is of prime importance since the cost of the regenerator and air blower amounts to approximately 75% of the cost of the cracking unit. The pressure of the reactor is usually fixed as low as possible in order to obtain the best possible yield structure. The regenerator operating pressure, however, can vary from 8 psig to as high as 25 psig, depending on the type of design offered. Operating the regenerator at low pressure requires a somewhat larger regenerator for a given coke-burning capacity, but there will be a noticeable saving in the air blower and utility consumption. On the other hand, operating the regenerator at a high pressure will reduce the size of the regenerator and improve the rate of combustion, the disadvantage, of course, being the higher utility consumption and more expensive air blower.

Additional pressure balance studies must be made to assure satisfactory operation of the unit under all of the anticipated throughputs and coke-burning rates. The slide valves must be designed to assure adequate control of the system under these varying operating conditions, but should also have a pressure drop limited to about 7 psi in order to avoid excessive erosion. The designer may at times specify two slide valves in series to provide the necessary operating flexibility with a minimum of erosion.

After the main pressure balances have been settled, thus establishing the relative elevations of the reactor-regenerator and the slide valve pressure drop, a pressure balance must also be made for the cyclones and dip legs. This balance should be made for the anticipated maximum throughput, since by establishing the balance in this manner, adequate dip leg is assured for all anticipated operations. One factor which cannot be neglected is the static head due to the presence of catalyst in the dilute phase, which may be quite appreciable.

Heat balances

The performance data which operating companies have accumulated for their catalytic cracking units have in some cases been correlated and programmed for computers and thus are available for the design engineers of such organizations. This is, of course, ideal for the process designer of a new unit, for he may then have immediate access to previous experience and easily translate it into the requirements of the new unit. There is, however, another aspect. Each cracking unit has its own typical characteristics, because equipment varies, and so does the relative efficiency of the reactor and regenerator. But for a new design, a new model, the coke formation, upon which the entire heat balance depends, may be different and thus require an adjustment to be made in the computer program in order to predict the operating characteristics of the projected operation. In view of this, one might wonder if the computer

MEET THE AUTHORS

WILLIAM C. CHATMAN is a senior process engineer with Foster Wheeler Corporation, in charge of petroleum conversion processes. He received a BS in chemical engineering from Drexel Institute of Technology and has been with Foster Wheeler since his graduation. His professional experience includes the design of vapor recovery units, complete ethylene plants, alkylation units, catalytic reforming and catalytic hydrodesulfurization units in addition to fluid catalytic cracking units.

CHIA WEI CHEN is a senior process engineer with Foster Wheeler Corporation, where he is in charge of formulating yields and design bases for petroleum refining and petrochemical processes. He received a BS in chemical engineering from Michigan University and an MS from Massachusetts Institute of Technology. Prior to his present duty, he was a process designer of catalytic and thermal cracking units, ethylene plants, and catalytic reformers. He was formerly with Socony Mobil Oil Company, Brooklyn, N. Y.

GEORGE T. ATKINS, Baytown, Texas, is a consulting engineer associated with Foster Wheeler Corporation in an exclusive arrangement, participating with the process plants division in design activities for the oil refining and petrochemical industry. Atkins, who received a BS from Washington University, St. Louis, in 1929, was formerly an engineering associate with Humble Oil and Refining Company. He is a member of ASME, AIChE and NSPE.

approach would still be reliable. It would not be entirely unexpected if the heat and material balances prepared by two or more technical groups of different background were found to differ substantially one from another. A way of reconciling these computer programs so they all give the same result would be to use the standard data from an existing unit, and include in each program factors such as to bring about the desired correspondence between observed and predicted results for each of the computer programs. Insofar as this procedure then fixes the stoichiometry and the heat balance relations, as a function of actual coke burned, it is in a sense equivalent to regarding the operating equipment of the catalytic cracking unit as a giant calorimeter from which the computer then obtains the net heat effects. Thereafter these net heat effects are included in and become a part of the respective computer programs. Each program meets the best test of all, that of giving the right answer—at least the right answer for the standard data. An operating company will be especially inclined to make full use of a computer because this permits the rapid determination of the optimum operation when changes in supply, demand, and price structure impose a readjustment of feed and conversion. When the computer is normally relied on to solve operating problems, its use easily can be extended to design problems as well.

In some cases, or maybe even in the majority of cases, it is still good design practice to prepare heat balances by hand rather than by computer. This permits the process designer to have a better understanding of the cause and effect relations within the heat balance. The calculations should always be checked in some way so as to insure accuracy and freedom from error. The calculation method should be consistent and reproducible and should, by all means, be calibrated against several operating units to assure that the calculation method corresponds to actual performance. It is, of course, to be assumed that the designer will have the benefit of the previous experience of his own organization and will have the benefit of previous calculations which he can use as models and examples. This then brings us to look at some of the special characteristics of heat balances around catalytic cracking units.

Heat content charts are available or can be constructed for all of the components appearing in the heat balance. It is not necessary that the heat content of each entering and leaving component be on a consistent basis; that is, that the datum be the same. For some components it may be desirable to convert from one datum to another when passing from one section of the heat balance into a second section. For example, water vapor leaving the regenerator may be taken as above ideal gas state at 60F, whereas steam to the cyclones may be above liquid at 32F as read from the steam tables. It is obvious that a compensating adjustment (the difference in heat content at the respective states) will have to be made to the heat contents of the entering and leaving streams in order that they can be on a consistent basis.

Heat of combustion for coke containing the nominal percent of hydrogen, usually eight or ten weight percent, can be read from charts. Or it can be taken additively for the elements. Part of the carbon burns to carbon monoxide and part to carbon dioxide, with different heats of combustion. Sulfur, if present, has a lower heat of combustion than carbon.

Mechanical heat is the heat equivalent to the work done by the machinery on the process fluids and originates principally in the main air blower, in the wet gas compressor, and also in the process pumps. Given the horsepower, the corresponding heat inputs can be found.

Heat losses usually can be estimated only in a rough way, but even so this should be done conscientiously and consistently from one operation to another and from one cracking unit to the next. After all, these commercial units are our calorimeters; their heat losses should be established. It would seem that the best way to measure the heat losses, if there could be a wish fulfillment, would be to make some test runs prior to start-up, on a unit supplied with metered quantities of air, fuel gas, steam, and cooling water. Then the heat losses could be found by difference, with both heat input and output more accurately known than during normal operation. The heat loss thus found by difference would still have to be pro-rated between the different vessels according to the exposed surface, the amount of insulation and the temperature inside the vessels; and for new design it would still be necessary to project these values to the proposed sizes and operating temperatures. But the concept is there; the heat loss is, in theory, measurable; and in any case it should be estimated as close as possible.

Heat of cracking is in principle predictable from known heats of formation (at 60F) of all of the hydrocarbons components, those entering in the feed and leaving in the products. However, as the chemical compositions are not known with any degree of exactitude, and as in any case the theoretical heat of cracking would have to be extrapolated from the standard state at 60F to the reactor temperature (using the net difference in enthalpies of feed and cracked products), it can be inferred that this theoretical approach is not destined to be successful. The heat of cracking in the now-obsolete thermal units (cracking coils), and especially in the coil-only variety, was more directly measurable than is the heat of cracking in modern fluid catalytic units. About the best approach seems to be to correlate the heat of cracking with either the formation of fixed carbon, or else with C_3 and lighter. As long as the correlation is reconciled consistently with operating data, the new designs are to that same extent insured against any serious error.

Catalyst circulation as measured on existing units, or as calculated for new units, is an item in the heat balances of both the regenerator and the reactor. In order that the heat balance on each vessel be correct, it is necessary that all items be on a consistent basis. This includes not only heat of cracking, but also heat losses, heat content charts, etc. For example, the specific heat of a typical catalyst is 0.26. One technique that has been used to measure circulation is to add a radioactive pellet to the circulating catalyst and then measure the average time required for it to make a circuit.

Advances are continually being made, in small steps, in the areas suggested by the various topics above; and technology will continue to develop in these areas as the need arises.

It is considered desirable to attain as high a *preheat temperature* as possible before injecting the feed into the hot catalyst entering the reactor. The higher the temperature of the liquid feed stream, the less stewing time there will be on the catalyst prior to vaporization, thus reducing the opportunity for thermal cracking and polymerization. The higher the feed preheat temperature the less coke formation, other things being equal. This is common experience.

A second effect of higher feed preheat temperature is to increase the heat input to the reactor. In order to stay in heat balance it is necessary to remove an equal amount of heat, and this is done by increasing the recycle ratio. The recycle feed passing through the reactor picks up both sensible heat and heat of vaporization. The effect of increasing the recycle ratio at constant reactor temperature is in

general to decrease the formation of coke. Which of these causes, decreased stewing or increased recycle ratio, has the greater effect in reducing coke formation? They occur simultaneously. So in any case there is every assurance that more favorable yields can be realized by preheating the feed to some maximum temperature just short of thermal cracking and coking.

What range of preheat represents good design practice at the present time? If a fired heater is installed, a feed preheat temperature of between 700 and 750 F can be attained without any particular difficulty. It is often considered advantageous to install such a fired heater; but, as the fired heater also represents a rather large addition to the investment, it is perhaps more often decided to omit it and instead to have the unit in heat balance, letting the carbon burned in the regenerator be the controlling source of heat input to the process. In this case, the amount of recycle is then varied within limits so as to adjust the heat balance and control the cracking reaction.

The feed preheat circuit should bring the fresh feed in heat exchange first with one or more product streams and then with circulating streams, the last of these being the fractionator bottoms pump-around circuit. The best design practice today is to preheat to at least 600 F, with 625 or 650 being preferable, and under the most favorable circumstances even as high as 675 F being attainable (with clean exchangers).

Light ends facilities

After recovering all the heat possible in the feed preheat circuit there is still a large excess of heat to be removed from the fractionator pump-around circuits. The best use for this excess heat is to reboil several towers of a light-ends unit associated with the cracking unit. A typical light-ends unit might include an absorber, a depropanizer, a debutanizer, and a naphtha splitter. Even after supplying the heat requirements of these facilities some heat removal duty will remain. Heat will be available at a temperature level perhaps up to 350 or 400 F and can be used in part for generating saturated steam for use in the cracking unit itself. The balance of the heat at lower level is then rejected either to air coolers or cooling water. The absence of light-ends facilities will tend to force the cracking unit to become a major source of steam generation for the refinery, whereas adjacent light-ends facilities will usually permit a more direct and economical flow of the heat that becomes available as a by-product of catalytic cracking.

Whether the light-ends facilities are adjacent to the cracking unit or remote from it, the duty of the wet gas compressor is set by the needs of the absorber associated with the light-ends facilities. Usually the absorber pressure is sufficiently high so that several stages of compression are necessary, with an inter and aftercooler and with associated knockout drums. The size of the wet gas compressor and the horsepower of its drive will be to an extent influenced by the suction pressure. It is desirable to have as high pressure as possible, but at the same time this pressure cannot be so great as to raise the operating pressure of the reactor. About 2 psig is a typical pressure at the suction of the wet gas compressor. Even with this moderate suction pressure some difficulty will always be found in keeping pressure drops back to the reactor at the desired low values.

Utilities

The utilities section of a modern cracking unit, when the concept is extended to include all the drives within the unit plus all the related steam and power generation, is of a size and complexity as to be a major feat of engineering in itself. The cost of all these facilities taken together is so high as to have a pronounced influence on the attractiveness of the final proposal for the complete cracking unit including utilities. The thoughts and efforts of many people are brought to bear on getting the most suitable answer to the utility problem; and a problem it is in view of the many choices and combinations which are open. It is unfortunately true that nowadays a unit built to minimum first cost may not be able to have its products disposed of profitably in a market where the price structure is established by other units having lower operating costs, such as may have been attained by better conservation. A trend is always observable toward higher capacities, or at least greater through-puts, after units have been in service awhile. Later the pressure drop in the steam mains increases and steam consumption goes up still more. This condition persists and becomes aggravated in the latter years when the older unit must compete with the latest and most efficient models. The experience of the industry seems to lead to the conclusion that the time is at hand when an extended payout time should be allowed for steam and power systems. Perhaps it becomes inevitable to accept rates of return approaching those we find for say a central generating station. Where would the difference in design choices then show up?

First of all **selection of a CO boiler** generating large amounts of high pressure superheated steam will probably be favored more often, in comparison with the older fixed tube sheet waste heat boilers generating saturated steam at relatively low pressure. The developments to be watched are those features which give maximum service factor of both the cracking unit and CO boiler, at minimum cost and with minimum sacrifice of independence of operation.

Use of gas turbine drives for the main air blowers has also been found to give reliable service. The complication of air filters can be avoided, instead cleaning the blades in service by periodic use of small amounts of air-suspended catalyst.

Combination of gas turbine with CO boiler has in at least one instance proved to be practical and economic. The hot exhaust gas contains more than sufficient oxygen for burning all the stack gas from the regenerator. But in a design, the duct work and the sequence of dampers is critical to success.

Wet gas compressor has a variable duty best handled by a rugged steam turbine. The characteristics of this turbine, and of the other process turbines, will be the result of a steam and power balance already set by choices described above.

This briefest of glimpses at the utility picture will show its place, a not unimportant one, in the overall design of the modern cracking unit.

NEW DEVELOPMENTS in process design are in the direction of **high conversions of improved feed stocks** at high recycle ratio, under operating conditions chosen closer than ever to give high yields of favored components. The use of **multiple transport reactors** is thought to be an attractive advance in this direction. An especial feature of the more recent units seems to be the coherence and sureness of their design, as shown by close thermal balance in the flow and in the utilization of heat and energy; and also in the dependability of the equipment and the long runs now obtainable. These modern units, be they large or small, are for a mature industry. They must be low in operating cost, designed so at the start, and capable of remaining so throughout a long useful life. ★ ★ ★

Part 1. General process design relationships.

Part 2. Applied process and mechanical design procedures.

"MOVING BED CATALYTIC CRACKING" denotes a catalytic cracking process in which the catalyst moves continuously and consecutively through reaction and regeneration zones in compact beds at its normal settled bulk density. Reactant vapors may be made to flow upward countercurrently to the catalyst or downward concurrently with the catalyst. The moving bed catalytic cracking process is a truly continuous process with the inherent advantage of plug-type flow of reactants and of catalyst in the reaction zones.

The moving bed technique has served the process industries in a variety of applications for many years.[1] The blast furnace and lime burning kiln are important examples and there are many others. However, it remained for the development of moving bed catalytic cracking for the petroleum refining industry to bring the technique to its presently advanced state. This required a thorough investigation of the fundamentals underlying solids flow and solids-gas contacting. Uniform reaction conditions and a

Moving bed catalytic cracking

A. WESLEY HOGE • RICHARD E. ASHWILL • EDWARD A. WHITE
Houdry Process Corporation, Philadelphia, Pennsylvania

low rate of attrition of the solids due to friction and impact had to be achieved. In many moving bed processes, especially those in which the solids are consumed, mechanical attrition of the solids is a relatively unimportant factor. But in moving bed catalytic cracking it is of major significance and affects the design of all of the physical equipment.

Basic requirements of a catalytic cracking system were defined in the early thirties in the development work leading to the first commercial catalytic cracking process, the Houdry Fixed Bed process. This early work established three fundamental principles:

- Cracking reactions would be carried out at or near atmospheric pressure and at temperatures from about 800 F to 1000 F.
- A carbonaceous deposit would accumulate on the catalyst during the cracking reaction, causing the catalyst to lose its activity rapidly.
- The activity of the catalyst would be restored by combustion of the coke with air. But, because substantial amounts of heat would be liberated, careful control of the burning would be necessary to avoid deactivation of the catalyst by overheating.

All of the catalytic cracking systems that have been commercialized have distinctive features of design to accommodate these three characteristics of the process. The operating conditions required for the hydrocarbon cracking reactions do not present any great problems. However, the temporary deactivation of the catalyst by coke deposited during the reaction period is a matter of great importance. The rate of deactivation by coke deposition and the relative difficulty of removing the coke without sintering the catalyst by high combustion temperatures led the early Houdry group to the conclusion that the new catalytic cracking process would be characterized by short, alternating cycles of cracking and regeneration. From a practical and economic standpoint, it was shown that the cycle time of the catalyst should be measured in minutes, perhaps 10 to 20 minutes on-stream and a similar time on regeneration. When this principle was enunciated, most of the catalytic processes known to the chemical and petroleum industries were non-regenerative.

The first catalytic cracking system utilizing the moving bed technique was the bucket elevator TCC unit which made its debut during World War II.[2] The Socony-Vacuum Oil Company* was responsible for the commercialization of this process and commissioned the first installation at its Beaumont, Texas, refinery in 1943. During the following five years, 33 additional units having a combined charge capacity of 400,000 bbl per stream day were installed. A major advance was made in 1948 with the advent of the gas lift for transporting catalyst in the moving bed systems. In that year Houdry announced its Houdri-flow process embodying this and other new features.[3] Socony followed with its own version of a moving bed process utilizing a gas lift for catalyst transport, known as the Air Lift TCC process. The provision for circulating relatively larger quantities of catalyst in the gas lift systems permitted operation at higher catalyst-oil ratios with corresponding reductions in the feed enthalpy and indirect heat removal facilities in the regenerator or kiln. However, at least one bank of cooling coils were retained as a characteristic design feature of the 45 gas lift moving bed units built between the years 1948 and 1959. The combined charge capacity of the gas lift moving bed units installed during this period is approximately 800,000 bbl per stream day.

*Presently Socony-Mobil Oil Company, Inc.

In 1960 Houdriflow HB process, a further improved and simplified version of Houdriflow process was offered to the industry. Process conditions are modified so that all cooling coils are eliminated from the kiln and a so-called "heat balanced" operation is attained. Units of this type have been designed in sizes ranging from 3000 to 75,000 bbl per stream day and the first commercial installation will soon be under construction. In this article the design and operating features of moving bed catalytic cracking systems will be presented largely in terms of the Houdriflow HB unit, inasmuch as its predecessors have been amply described in the technical press. Fig. 1 and 2 present simplified flow diagrams which illustrate the salient features of the four moving bed systems.

The grand total of installed moving bed catalytic cracking capacity in the United States, 1,200,000 bbl per stream day, corresponds to nearly 30% of the total catalytic cracking capacity in the country. Thus, moving bed catalytic cracking plays a substantial role in the petroleum refining industry. Moreover, the moving bed principle is certainly destined to be employed in an increasing number of applications in the process industries generally.

HB Houdriflow process

The functions of the various components of the HB Houdriflow unit will be described with references to the flows of catalyst, oil, air, and steam through the unit as depicted on Fig. 2.

Perhaps the most important requirement of any moving bed cracking process is the maintenance of a uniform horizontal profile of catalyst velocity as the catalyst gravitates through the unit in a compact mass. Continuous solid bed flow is obtained by regulating the catalyst flow rate only at the lift engager and sizing all internal flow elements in the kiln and reactor such that their ultimate flow capacities are well above the design circulation rate. A uniform catalyst flow rate over the cross-section of each reaction zone is also established at the bottom of the unit by a carefully designed withdrawal system.

Starting at the top of the unit in Fig. 2, catalyst flows to the reactor from the combination lift disengager-surge hopper (A) through a seal leg (B). The surge hopper is at atmospheric pressure, while the top of the reactor is usually at the pressure of 10 to 12 psig, depending upon the

back pressure imposed by the synthetic crude fractionator and the pressure drop through the reactor bed. To prevent escape of hydrocarbon vapors via the seal leg, sealing steam is introduced into the plenum (C) at such a rate that the static pressure in the plenum is maintained slightly above reactor pressure. Thus , there is a flow of steam both up the seal leg and downward into the reactor.

From the top seal head some 80 to 95% of the catalyst flows into the reaction zone through a centrally positioned orifice (D), from which it is discharged as a free-falling, dispersed annular curtain. This catalyst curtain surrounds the mixed-phase hydrocarbon feed nozzle (E), so that the hollow-cone spray from the nozzle disperses among and mixes with the catalyst particles.

Although one of the recognized advantages of a moving bed system is plug-type flow, i.e., no turbulence, cross flow or back-mixing of catalyst and reactants in the reaction zones, acceptance of this advantage is conditioned upon the uniform introduction of hydrocarbon charge into the reaction bed. When the hydrocarbon charge is mixed-phase, as is usually the case, it is essential that there be substantial intermixing of feed and catalyst so that the liquid is well distributed on the catalyst particles and each particle of catalyst has an opportunity to give up some heat to the liquid charge. The degree of success attained by this type of introduction system can be measured in horizontal temperature profiles taken at the bottom of the reaction zone. These show a very acceptable level of uniformity. A typical profile is plotted in Fig. 3.

The remaining 5 to 20% of the circulating catalyst flows into the reactor through a circle of peripheral pipes (F) which serve to maintain the top of the reactor catalyst bed at a fixed level. Their length is predetermined to give a bed depth meeting the space velocity requirement for the desired throughput.

Hydrocarbon vapors and catalyst move concurrently downward through the reactor bed to the vapor disengaging section (G). The function of this device is to separate the reaction products from the catalyst without entrainment of catalyst particles. The disengagement occurs at the free surface of the catalyst under the several levels of inverted, U-shaped channels. Vapors collected under the upper levels of channels flow through vertical vapor tubes to the deep bottom channels, which serve as both disengaging and collecting channels. The collected vapors flow horizontally outward through the bottom channels to the annular plenum surrounding the vapor disengager. A transfer line carries reaction products to the synthetic crude fractionator from the annular plenum. The vapor disengaging section is shown in some detail in Fig. 4.

Catalyst, as it gravitates to the kiln, passes through the purge zone where it is stripped with a countercurrent flow of steam to remove hydrocarbons trapped in the voids between particles and adsorbed on the catalyst. Stripping takes place in purge pipes (H) mounted in a tube sheet on a concentric circular pattern. Purge steam is piped into the plenum formed below the tube sheet by the projection of the purge pipes. Part of the steam introduced at this point

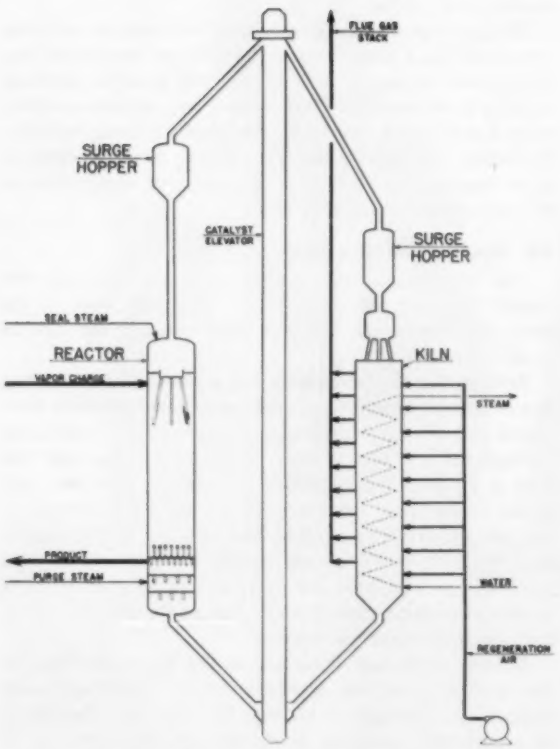


FIG. 1a. Bucket Elevator TCC.

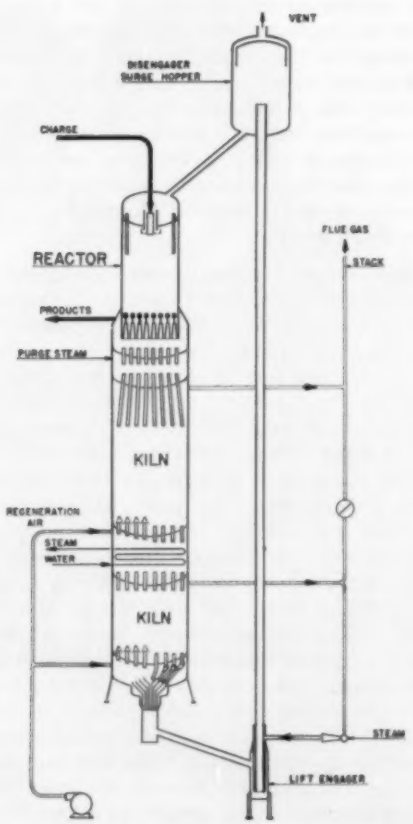


FIG. 1b. Houdriflow.

flows downward through seal pipes (J) into the kiln, acting as a sealing medium to separate the hydrocarbon vapors in the reactor from the flue gas in the kiln. The differential pressure imposed on the seal pipes is usually 6 to 7 psi.

In the HB Houdriflow design, regeneration of spent catalyst is accomplished in a single, countercurrent burning zone without any heat removal via cooling coils either during or after regeneration. Thus, there is a temperature gradient from approximately the reactor temperature at the top of the burning zone to a maximum regeneration temperature near the bottom of the zone. To achieve a uniform horizontal temperature profile regeneration, air is introduced beneath the air inlet tube sheet and distributed uniformly among a multiplicity of air engaging caps (K) somewhat similar to bubble caps on a fractionator tray. The air flow and pressure drop relationships permit the utilization of a single-stage centrifugal blower for the supply of combustion air, the top of the burning zone being held slightly above atmospheric pressure.

As illustrated in Fig. 5 the catalyst is withdrawn from the kiln through a multiplicity of downcomer pipes in the air inlet tube sheet which feed into a nest of concentric funnels (L) terminating in the kiln outlet line. Catalyst from the withdrawal system flows to the lift engager (M), the function of which is to accommodate the entrainment of catalyst particles into the lift gas stream.

Catalyst is transported in dilute phase up the lift pipe, a straight pipe topped by a decelerating taper. Lift gas is provided by recompressing a portion of the kiln flue gas

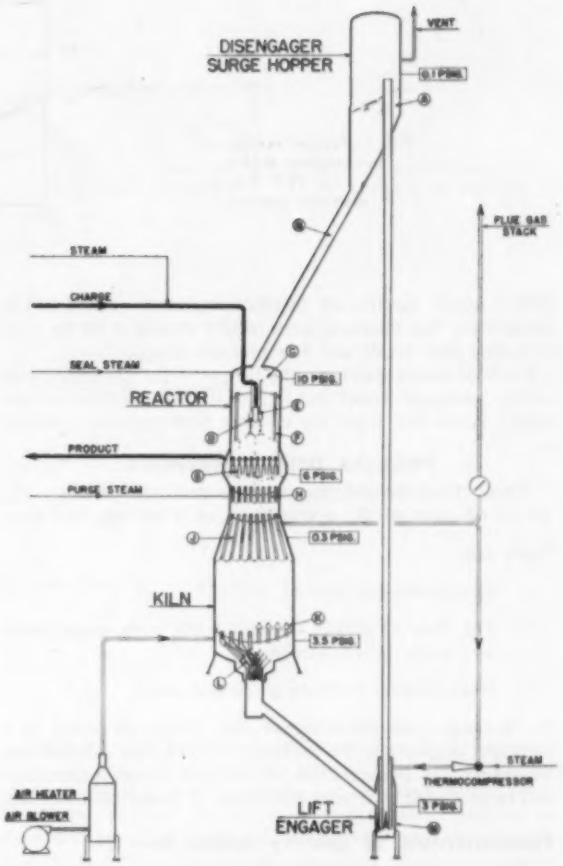


FIG. 2. Houdriflow HB.

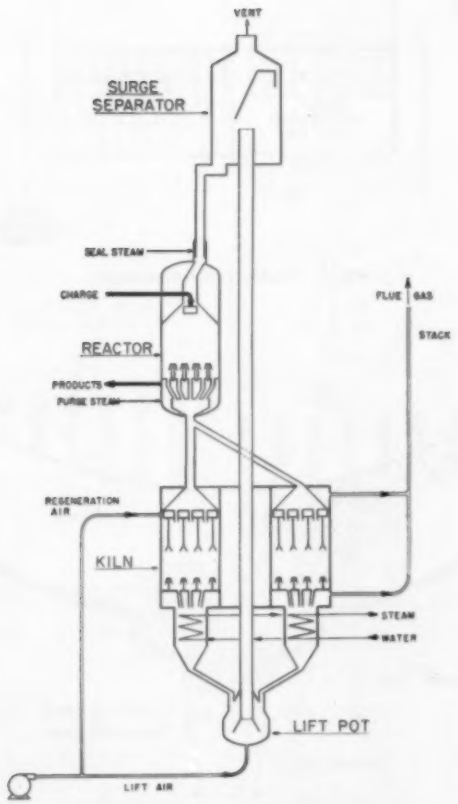


FIG. 1c. Socony Airlift TCC.

MEET THE AUTHORS

A. WESLEY HOGE, manager of engineering for Houdry Process Corporation, holds several patents and is author of numerous papers in the catalytic cracking field. Joining Houdry in 1943 after several years with United Gas Improvement Company, Philadelphia, he served as an engineer with the technical service division, supervisor of the technical service team, and supervisor of process design before assuming his present position in 1953. Hoge has a BS in metallurgical engineering from Ohio State University.

RICHARD E. ASHWILL, section head in Houdry's research and development laboratories, Linwood, Pennsylvania, has been concerned with process development and economic evaluation on petroleum, catalyst manufacture, and organic chemical processes during his nine years with the company. He holds a BS from Carnegie Institute of Technology, a BA from Baldwin-Wallace College and has done graduate work at the University of Delaware. He has written several papers and holds four patents.

EDWARD A. WHITE, senior process engineer with Houdry, has worked with economic studies and process designs in the catalytic cracking and refining areas and also has served as field process engineer in Houdriflow unit start-ups since coming to the company in 1946. White received a BS in chemical engineering from the University of Pennsylvania and was a pilot plant engineer with Cities Service Refining Corporation prior to his service with Houdry. He is author of several papers.

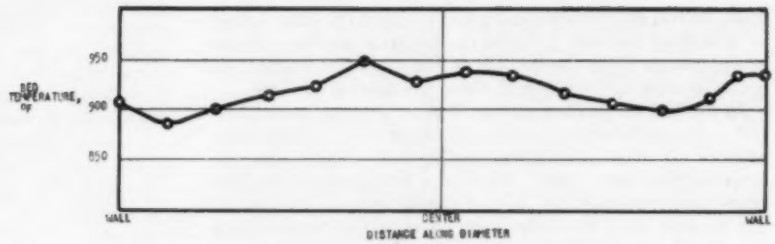


FIG. 3. Typical reactor temperature profile for 18-ft 7-in. diameter reactor.

with a steam ejector, or thermocompressor. The thermocompressor has characteristics which enable it to be used as both a flow meter and flow control device.

Catalyst disengages from the lift gas in the expanded area of the disengager vessel and falls to the surge section of that vessel. From this point the catalyst flow cycle is repeated.

PROCESS DESIGN METHODS

Three fundamental mechanisms underlie the process design of most of the components of a moving bed unit. These are:

1. The gravitating flow of solids.
2. The flow of vapors through solids beds, particularly in countercurrent systems.
3. Heat transfer between gases and solids.

A thorough understanding of the nature of these is a principal requisite to the making of any design calculations. Therefore the presentation of detailed design procedures will be preceded by a brief discussion of these fundamentals.

Fundamentals of gravity solids flow

Two important, fundamental properties of granular solids flow are:

Angle of internal friction, α

Angle of repose, β

These, and other characteristics of lesser importance, have been measured on a variety of systems in the Houdry laboratories and also by numerous other investigators, notably Rausch.[4] Zenz[5] has given an excellent review of the flow characteristics of bulk solids as well as some typical values of physical properties. No effort will be made here to give another detailed discussion of the subject. However, typical values of these flow properties will be given for moving bed cracking catalyst, and the general use of such factors in designing a Houdriflow unit will be indicated.

The angle of internal friction, as the name implies, is the angle formed between flowing and stationary solids. This angle is commonly considered to be a constant for a given material. Such is not actually the case. The tangent of α is the coefficient of internal friction, μ, defined as the tangential shearing force necessary to cause shearing divided by the normal force. This friction coefficient is dependent on the degree of expansion of the bed and the ratio of horizontal to vertical solids pressures. Although the last two variables are extremely difficult to measure directly, their effect on μ (and therefore α) is readily noticeable in large scale solids flow experiments. The actual values of α vary with solids velocity and size of the flowing mass of solids. At high velocities a gravitating bed tends to expand and the larger void space between particles decreases the friction coefficient. Also, with a flowing cone of solids being withdrawn from a vessel, the internal friction angle is greatest at points on the shear surface farthest from the withdrawal point. These effects are depicted in the three sketches of Fig. 6.

For most cases of catalyst flow encountered in Houdriflow design the value of α lies between 68 deg and 75 deg. Experimentally, values as high as 82 deg have been encountered. The value of α is important in the design of all catalyst withdrawal systems. Examples are the flow of catalyst from the lift disengager into the top seal leg, each tube sheet in the kiln-reactor vessel, and the final catalyst collector system at the bottom of the kiln. In all cases α influences the type of system employed, e.g., number and arrangement of downcomer pipes in a tube sheet required to achieve uniform flow over the entire cross-sectional area.

The angle of repose, β, is essentially a special case of the

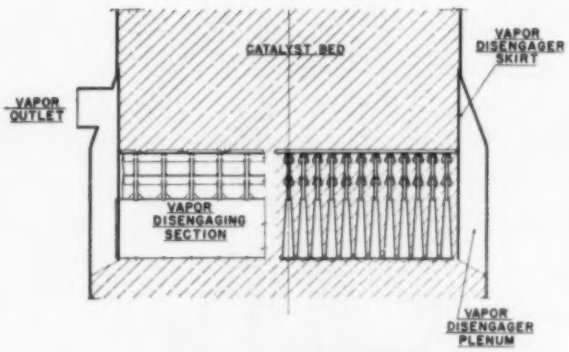


FIG. 4. Reactor vapor disengager.

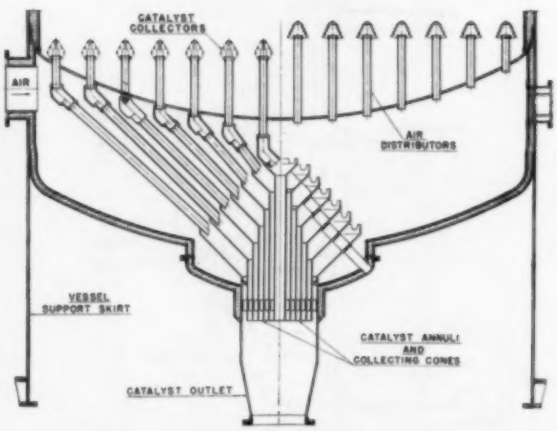


FIG. 5. Kiln catalyst draw-off and air engaging system.

angle of internal friction. Here again the coefficient of friction (solids on solids) is the tangent of β. However, in this case, solids pressure and the ratio of horizontal to vertical solids pressures are not factors. The only force involved in determining angle of repose is the weight of the last layer of particles which flow along the sloping surface of an *exposed* solids bed. The final angle assumed by this bed when flow ceases is the conventional angle of repose. This angle is approached by the top surface of a gravitating bed of solids flowing at low velocity. However, as with the angle of internal friction, high velocities cause an increase in the angle formed at the top surface of the bed. Though it is a misnomer, this is sometimes termed the dynamic angle of repose. Several manifestations of these effects are shown in Fig. 7.

The conventional angle of repose for moving bed cracking catalysts is in the range of 30 deg to 35 deg. This catalyst property affects Houdriflow design at each location where catalyst is discharged from a small flow area, generally a tube, into a large area, such as reactor bed or kiln bed.

Experimental data on the flow capacities of pipes and orifices have been correlated for use in Houdriflow design. Data for a selection of moving bed cracking catalysts varying from equilibrium bead catalyst of 0.10-in. particle diameter to new pelleted catalyst of 0.17-in. particle diameter were employed in the correlation. For all practical purposes it may be assumed that the effect of solids head on flow is negligible.

The form of the final correlations, Equations 1 and 2,

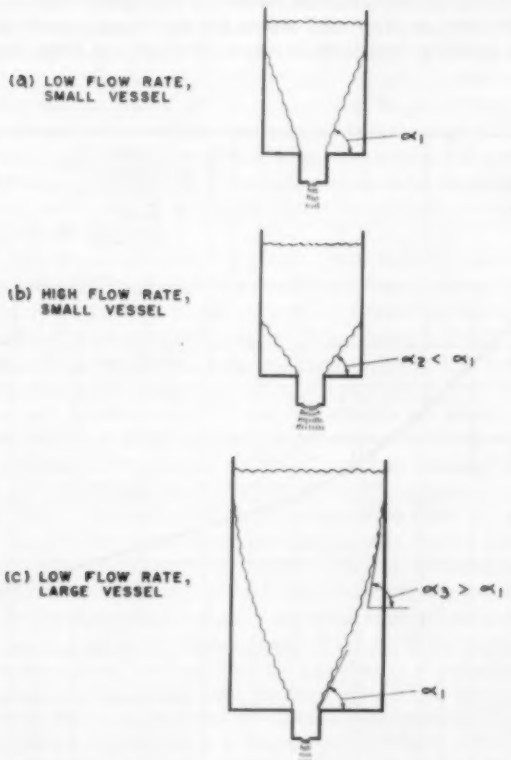


FIG. 6. Schematic representation of solids angle of internal friction.

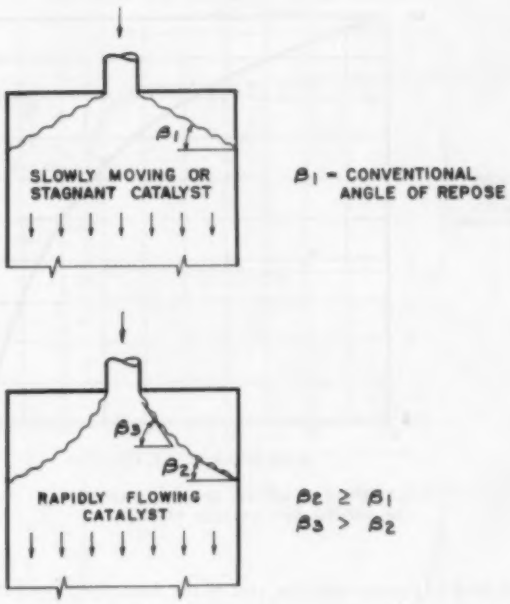


FIG. 7. Schematic representation of solids angle of repose.

is based on observations of maximum flow in half-section plexiglass pipes in which it appeared that the actual restriction occurred slightly above the entrance to the pipe. Furthermore, this restriction was somewhat smaller in diameter than the inside of the pipe. Thus, an effective pipe diameter was defined as true inside diameter minus a constant, the constant being an empirically determined property of each solid.

$$Q_p = 0.698\ (d_p - n)^{7/3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$Q_o = 0.471\ (d_o - n)^{5/2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Where Q = ultimate flow capacity, cu ft per min.

d = diameter of pipe or orifice, in.

n = constant, property of solids.

Subscript $_p$ refers to pipes

Subscript $_o$ refers to orifices

The value of n for cracking catalyst varies from 0.4 for 0.10-in. diameter beads to 0.8 for 0.17-in. diam pellets. Data for 50 to 70 mesh Ottawa sand correlate at an n-value of 0.03.

The foregoing correlations predict ultimate capacity in the absence of gas flow. Generally, however, catalyst pipes in a Houdriflow unit have a pressure gradient and, of course, a corresponding vapor or gas flow within the pipes. If the gas flow is counter-current to catalyst flow, the pipe capacity is reduced. The extent of this reduction is shown in Fig. 8. This correlation is used in conjunction with the above pipe capacity equation for sizing Houdriflow catalyst piping.

One unique, though usually undesirable characteristic of solids flow involves particle size segregation. In general, whenever the direction of flow of a bed of gravitating solids is changed there is a tendency for segregation according to particle size. For example, if catalyst with a range of particle sizes flows from a feed pipe into a large cylindrical vessel, the largest particles tend to roll to the vessel periphery, whereas the finer particles sift through the top bed surface

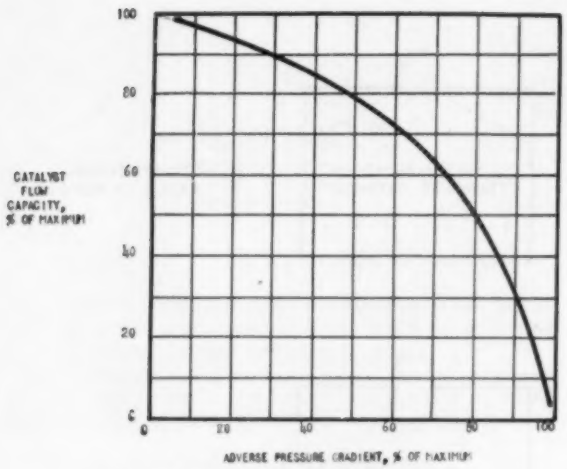


FIG. 8. Effect of adverse pressure gradient on catalyst flow capacity of pipes.

and tend to remain near the axis of the feed pipe. The principal effect of size segregation is uneven flow of vapors through the total bed because of the difference in flow resistance between zones of coarse and fine catalyst. In commercial practice the deleterious effect is minimized by

1. Maintaining a narrow range of particle sizes in the system, since the degree of segregation is proportional to the range of particle sizes.
2. Designing the internals such that variable distribution of particle sizes is avoided.

Both approaches are used in Houdriflow design and operation.

First, natural elutriation in the catalyst lift system combined with external classification of a slip stream tends to maintain a narrow range of particle sizes in the circulating catalyst stream. A typical screen analyses of circulating Houdriflow catalyst shows –

1.0 wt % on Screen 4 (Tyler Std. Scale)
65.5 wt % on Screen 5
15.5 wt % on Screen 6
9.0 wt % on Screen 8
7.5 wt % on Screen 10
1.5 wt % through Screen 10

Second, the one location in the system which is most likely to be affected adversely by segregation is just above the reactor inner head, but here the type of oil-catalyst feed system used ameliorates the problem by redistributing the particles over the top of the reactor zone.

Typically, in a system where the average catalyst particle size is 0.145 in., the variation in particle size of samples taken at regular intervals across the diameter of the reactor may range from 0.16 in. to 0.13 in.

Fundamentals of vapor flow in solids beds

Flow of vapors through moving or static beds of catalyst and through catalyst in pipes, is essentially plug-type, with virtually no cross flow or mixing. This statement assumes uniform engaging of vapor into the bed cross-section, as at the top of the reactor bed, or uniform disengaging from the bed, as at the top of the kiln.

Since the vertical pressure drop across all sections of the bed is the same, a uniform flow of vapor will exist only as long as there is no substantial variation in catalyst particle size over the cross section. Some size segregation does usually occur, as mentioned above, but the extent is such that the resulting variations in vapor flow are not more than

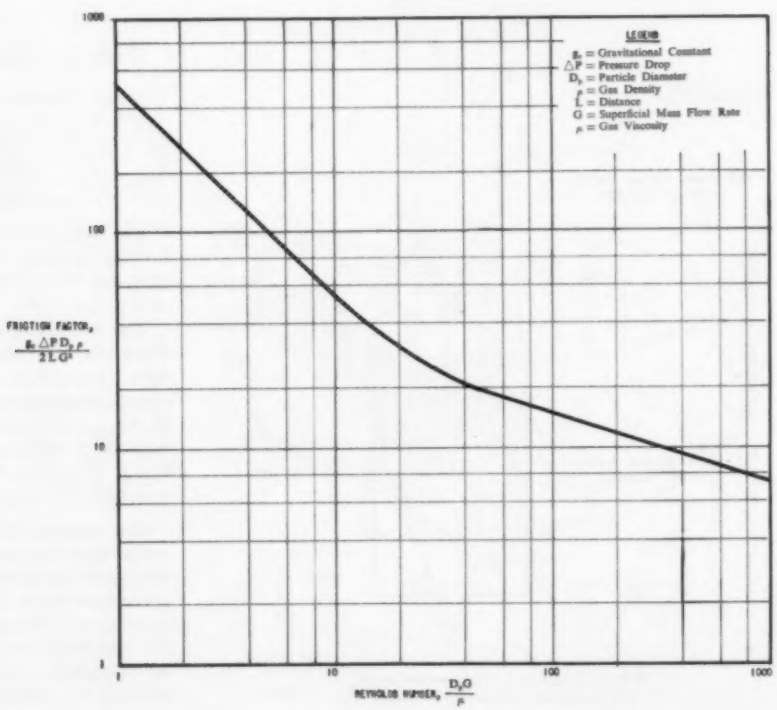


FIG. 9. Pressure drop due to vapor flow through moving solids beds.

about ± 8% from the average. Nonuniformity of this magnitude has no significant effect on product distribution or on coke deposition on the catalyst.

Pressure gradient due to vapor flow through moving beds of catalyst is calculated with the aid of a correlation of Reynolds number vs. friction factor. The relationship is shown in Fig. 9. Various experimenters have published correlations more or less similar to this, some with modifications and factors by means of which data on widely varying systems can be related.[6] One refinement has to do with the relative velocities of the solids and fluid; however, for many commercial applications this correction is negligible. The use of Fig. 9 has been adequate for Houdriflow design.

Pressure gradient calculation is used, of course, for establishing bed pressure drops and for estimating the flow of seal gas through seal legs. In addition, pressure gradient in countercurrent flow also defines maximum operating limits for seal legs and for vapor disengagement from the surface of catalyst beds. By simple force balance, this maximum adverse gradient can be shown to be equal to the flowing bulk density of the catalyst, normally 45 to 50 lb/ft³/ft (8.5 to 9.5 in. of water/ft). At this gradient, catalyst flow in smaller diameter seal legs is interrupted completely by bridging. Larger legs may continue to operate, but flow is slug-like and unacceptable for moving bed operations. When disengaging vapors from the surface of a catalyst bed, operation at the maximum gradient results in lifting of the bed surface and likewise is undesirable. This phenomenon, known as "boiling," would cause appreciable catalyst attrition.

Heat transfer in moving beds

Gas-solids heat transfer in moving bed systems occurs extremely rapidly because of the intimate contact between the gas and the finely divided solids. Heat transfer coefficients in the Houdriflow system are generally in the range of 30 to 150 Btu/hr/ft²/F. Per unit of bed volume (ft³) the equivalent transfer rates are 9000 to 45,000 Btu/hr/F. In applying such transfer rates to air-catalyst or hydrocarbon-catalyst contact in a Houdriflow unit, one may readily calculate that somewhat less than one inch of length of catalyst bed is required for fluid and catalyst temperatures to approach one another to within 1 deg F. In fact, for many engineering calculations it is satisfactory to make the simplifying assumption of an infinite rate of heat transfer between the two phases.

This characteristic of the system leads to some interesting generalizations regarding bed temperature profiles. The type of temperature profile obtained in countercurrent contacting of a gas and gravitating solids bed depends largely on the ratio of the flowing heat capacities of the two streams. (By flowing heat capacity is meant the product of mass flow rate and specific heat.) If a low temperature gas stream of low total heat capacity is contacted countercurrently with a high temperature solids stream of high heat capacity and there is no reaction heat involved, the bed temperature profile shows essentially inlet solids temperature from the top of the bed down to a point near the gas inlet. At this point the bed temperature drops rapidly (because of extremely high transfer rate) to a solids outlet temperature consistent with total heat balance. If, with the same inlet temperatures of gas and solids, the heat capacity of the gas is the greater, the majority of the bed from the gas inlet to a point near the top is at essentially inlet gas temperature. The top portion of the bed then shows an increase in temperature with the gas leaving the bed at a temperature consistent with the overall heat balance. Of course, in the reactor and kiln of a moving bed catalytic cracker, the endothermic heat of

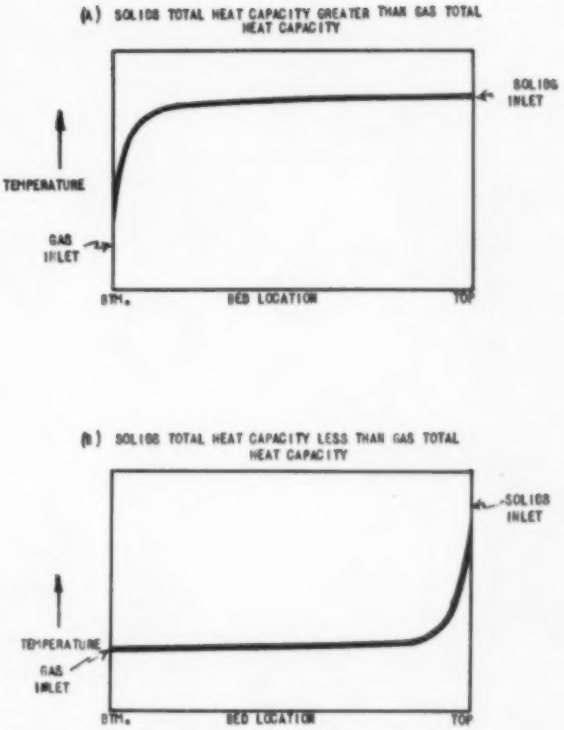


FIG. 10. Typical temperature profiles — countercurrent contacting of hot solids and cold gas.

cracking and the exothermic heat of combustion are superimposed on the respective profiles. Typical temperatures profiles for several of these cases are shown in Fig. 10.

A special case of academic if not practical interest arises when the flowing heat capacities of the gas and catalyst in countercurrent flow are equal. A simple heat balance over a small increment of reaction bed leads to the expression,

$$H = (T_1 - T_2)\ (W_c\ C_c - W_g\ C_g) \quad . \quad . \quad (3)$$

where H = heat of reaction, Btu/hr

T = temperature, F

W = flow rate, lb/hr

C = specific heat, Btu/lb/F

subscripts 1 = catalyst inlet and gas exit

2 = catalyst exit and gas inlet

c = catalyst

g = gas

As the flowing heat capacities approach the same value, the second factor on the right approaches zero, and a very large ΔT may be required in the bed to satisfy the heat balance equation. For an endothermic reaction this would represent a large temperature depression, and for an exothermic reaction a steep temperature rise. In a Houdriflow system it is not necessary or desirable to design in the region of this phenomenon, but it is important to recognize its existence and the significance of it. The general subject of heating and cooling of flowing solids is treated in detail by Payne, et. al.[7]

To Be Continued Next Month

So Long... Until Tomorrow It took five flat cars to ship this 195 foot-long fractionating column from our Orange, Texas, plant. Even the Texans thought it was a whopper, but tomorrow we'll be fabricating bigger ones—that's the way it goes. ☐ This column went to a leading refinery where it produces high purity isobutane, a component of premium gasoline. ☐ The 12-foot diameter steel column is made up of 20 rings or sections, each ¾ of an inch thick. The rings are welded together, then welded to a 20-foot skirt which supports the tower in its upright position. After fabrication the column was stress relieved.

Our Orange, Texas plate shop can handle custom plate work of all kinds and sizes. We have experienced men and the right equipment, high capacity cranes, giant presses and bending rolls, the latest welding equipment, mammoth car bottom furnaces, and complete inspection facilities. We can ship by rail, truck or barge. And anything we make, we can erect. ☐ Write for our booklet on plate fabricating facilities and services.

USS is a registered trademark

This mark tells you a product is made of modern, dependable Steel.

General Offices: 525 William Penn Place, Pittsburgh, Pa.
Contracting Offices in: Ambridge • Atlanta • Baltimore • Birmingham
Boston • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit
Elmira • Gary • Harrisburg, Pa. • Houston • Los Angeles • Memphis
Minneapolis • New York • Orange, Texas • Philadelphia • Pittsburgh
Portland, Ore. • Roanoke • St. Louis • San Francisco • Trenton
United States Steel Export Company, New York

American Bridge Division of United States Steel

USS

HARSHAW
FLUORIDES

Boron Trifluoride
Hydrofluoric Acid
ANHYDROUS . . . AQUEOUS

The uses for Fluorides are ever increasing. Harshaw Fluoride production also has increased steadily. Shipments of cylinders and tank cars leave our plant daily. If required, you are invited to draw on the knowledge and experience of our staff of technical specialists on Fluorides.

Write for your free copy of M.C.A. Chemical Safety Data Sheet SD-25 on properties and essential information about...
HYDROFLUORIC ACID
Anhydrous and Aqueous

THE HARSHAW CHEMICAL CO.
1945 EAST 97th STREET • CLEVELAND 6, OHIO
Chicago • Cincinnati • Cleveland • Detroit
Hastings-On-Hudson, N. Y. • Houston
Los Angeles • Philadelphia • Pittsburgh

Here is a helpful list of HARSHAW high-quality fluorides:

Ammonium Bifluoride
Ammonium Fluoborate
Barium Fluoride
Bismuth Fluoride
Boron Trifluoride Complexes
Chromium Fluoride
Copper Fluoborate
Fluoboric Acid
Fluorinating Agents
Frosting Mixtures
Hydrofluoric Acid Anhydrous
Hydrofluoric Acid Aqueous
Hydrofluosilicic Acid
Laboratory Fluorine Cells
Lead Fluoborate
Lithium Fluoride
Metallic Fluoborates
Potassium Bifluoride
Potassium Chromium Fluoride
Potassium Fluoborate
Potassium Fluoride
Potassium Titanium Fluoride
Silico Fluorides
Silicon Tetrafluoride
Sodium Fluoborate
Tin Fluoborate
Zinc Fluoborate
Zinc Fluoride

HARSHAW

The Ideal Combination For Your

PERSONAL ENGINEERING BOOKSHELF

1 Personal Copies of Handbooks Reprinted From The Engineer

☐ **HOW TO BE A MANAGER**
Oil industry leaders tell you How to Define Your Goal, Prepare for Promotion, Check Your Progress—a 40-chapter series appearing in monthly issues of the "Engineer"; handbook contains all published to date.

Drilling and Producing Handbooks

☐ **HOW TO EVALUATE AND DEVELOP GAS-CONDENSATE RESERVOIRS**
W. C. Goodson's 8-chapter analysis of fundamentals for evaluating and developing Gas-Condensate Reservoirs; from discovery through economic depletion.

☐ **FUNDAMENTALS OF ROTARY DRILLING**
Newly revised 5th edition . . . 40 practical chapters on Drilling Techniques, Equipment Selection and Maintenance. Over 18,500 copies in use throughout the oil industry.

☐ **WELL WORKOVER HANDBOOK**
Tells when wells should be reworked . . . what techniques to use . . . how to check results.

☐ **FUNDAMENTALS OF OIL AND GAS PRODUCTION**
Tells the most successful production techniques . . . from the time a hole reaches pay dirt until production is flowing through the pipeline.

☐ **ELEMENTS OF WATER INJECTION**
J. Randolph Buck's analysis of the methods that bring maximum recovery at the greatest profit . . . covers all steps including planning the program and evaluating the results.

☐ **PRACTICAL PETROLEUM ENGINEERING PRACTICES**
The complete "Atlantic Lectures" as presented at the University of Texas and published exclusively by The Engineer. 14-chapters, 17 top-flight engineers and superintendents in production, research, drilling.

Refining-Petrochemicals Handbooks

☐ **REFINING FUNDAMENTALS**
A book-length series on petroleum refining processes by Dr. V. A. Kalichevsky.

☐ **MODERN GASOLINE PLANT DESIGN, ECONOMICS, OPERATION AND EQUIPMENT**
Ten chapters covering cold absorption, conventional absorption, abbreviated plants, refrigeration, dehydration, treating gas and water, plant instrumentation and plant cost estimating. Text amplified by 65 flow charts, tables, nomographs and check lists.

☐ **MECHANICAL DESIGN OF PROCESS TUBULAR HEATERS**
Dr. L. A. Mekler's step-by-step analysis of heaters design methods, engineering calculations, choice of materials and economics of design and operations.

☐ **CHOICE, DESIGN, AND MAINTENANCE OF CENTRIFUGAL PUMPS**
Covers pump design and operation, including most frequent troubles, their causes, how they can be minimized or eliminated.

☐ **FINNED TUBE HEAT EXCHANGER DESIGN METHODS**
Liquid-liquid, partial and complete condensing finned tube heat exchanger design.

☐ **HYDROCARBON ABSORPTION AND FRACTIONATION PROCESS DESIGN METHODS**
A 132-page review and comparison of the many methods proposed during recent years, plus design methods developed by Dr. W. C. Edmister.

Pipelining Handbooks

☐ **THE PIPELINE TABLES**
A 180-page Handbook developed by practicing engineers to speed calculations in all phases of pipelining.

☐ **GAS TRANSMISSION AND PIPELINE FUNDAMENTALS**
Reprints of all chapters that have been published to date in this popular Personal Study Course.

☐ **PIPELINE HANDBOOK**
Annually revised special issue of the Pipeline Engineer — academic and advanced data presented in concise, easy-to-read tables, charts and methods descriptions for solving crude, products and gas pipeline problems.

☐ **CORROSION NOTEBOOK**
Sixty-four page manual on corrosion — what causes it, how to prevent it, how to find it, case histories, unique ideas in equipment and materials applications.

2 Personal Subscription To The "Engineer" Edited Expressly For You

ACCEPT ONE HANDBOOK FREE WITH YOUR SUBSCRIPTION

SUBSCRIBERS: ORDER ADDITIONAL HANDBOOKS FOR ONLY $1 EACH

Enter my order:	☐ New	☐ Renewal	One Free Handbook
PETROLEUM ENGINEER, Drilling & Producing	☐ $2 YR.	☐ $4 THREE YRS.	Add. Handbook(s) @ $1
PETRO/CHEM ENGINEER	☐ $2 YR.	☐ $4 THREE YRS.	
PIPELINE ENGINEER	☐ $2 YR.	☐ $4 THREE YRS.	
PETROLEUM ENGINEER FOR MANAGEMENT	☐ $4 YR.	☐ $9 THREE YRS.	

Name _____

Title _____

Company _____

Address _____ ☐ Home ☐ Company

City _____ Zone ____ State _____

Check Your Division(s):

☐ Drilling	☐ Pl. Contr.
☐ Drlg. Contr.	☐ Refining
☐ Producing	☐ Petrochemical
☐ Ind. Prod.	☐ Nat. Gasoline
☐ Well Service	☐ Engr.-Constr.
☐ Oil Pipeline	☐ Supply Co.
☐ Products Pl.	☐ Service Co.
☐ Gas Trans.	☐ Manufacturer

PETROLEUM ENGINEER PUBLISHING COMPANY
BOX 1589 DALLAS 21, TEXAS

ENGELHARD

standard or custom PRECIOUS METAL CATALYSTS for use in the organic and petroleum chemical industries

Engelhard PRECIOUS METAL CATALYSTS are available...on a wide variety of carriers ...in the form best suited for your needs...in the concentration most economical for your purpose

ENGELHARD'S MOST WIDELY USED SPECIES

	ALUMINA-SUPPORTED CATALYSTS
5%	Pt, Pd, or Rh on alumina powder
0.5%	Pt, Pd, Rh, or Ru on alumina pellets or spheres
0.3%	Pt on alumina pellets or spheres
	RD 150 or RD 150C

	CARBON-SUPPORTED CATALYSTS
5%	Pt or Pd on activated carbon powder
5%	Rh or Ru on activated carbon powder
0.2%	Pd on granular carbon

	OTHER CATALYST SPECIES
5%	Pd on $CaCO_3$ or $BaSO_4$ powder
	Pd or Pt oxide
	Pd or Pt black

For efficiency in promoting various laboratory chemical reactions and in large scale reactions including fabrication of rocket fuels, plastics and textile intermediates, high octane gasoline, heavy chemicals and fine pharmaceuticals, *consult with the Chemical Division of* ENGELHARD INDUSTRIES, INC. where *the world's largest research and production facilities* in the field of PRECIOUS METAL CATALYSTS are combined *to meet your requirements.*

ENGELHARD

INDUSTRIES, INC.

CHEMICAL DIVISION

113 ASTOR STREET · NEWARK 2, NEW JERSEY

SALES OFFICES THROUGHOUT THE WORLD.

LEADERS IN MANUFACTURING AND REFINING OF PRECIOUS METALS CATALYSTS FOR OVER THIRTY YEARS

C-54b

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

the 1st

the American Institute of Chemical Engineers announces...

A.I.Ch.E. PETROCHEMICAL AND REFINING EXPOSITION!

For some time, the A.I.Ch.E. has been aware of an increasing demand for a petrochemical and refining exposition... to bring together in one place the seemingly inexhaustible number of new developments and new ideas associated with this dynamic and expansive field... and to put it into its proper focus in the overall chemical and petroleum picture.

NOW— for the first time in history—this show becomes a reality!

THE TIME: FEBRUARY 26—MARCH 1, 1961

THE PLACE: NEW ORLEANS, LOUISIANA

will you be there? This is *one* exposition you should not miss, for it will bring together under one roof some of the most important developments in the field... developments that you, as a chemical or petroleum engineer, should know about in intimate detail.

Sponsored by the American Institute of Chemical Engineers, the first Petrochemical and Refining Exposition will be held in conjunction with a national meeting of the A.I.Ch.E. Exhibits will be at the Municipal Auditorium, and meetings will be held there as well as at the Roosevelt Hotel. Fabled New Orleans is the ideal site for this important show—for 85% of the petrochemical industry and 35% of the refining industry are within a radius of a few hundred miles.

Several hundred exhibitors will display their products and services, with equal space being planned for both petrochemicals and refining. Papers presented at the meeting will be among the most important of the year, and will be released simultaneously to all publications. And for a big "plus," many interesting plant trips in the vicinity are being planned for you to attend.

The tentative program will feature sessions on kinetics, petrochemicals, future of the industry on the Gulf Coast, solids, future processing technology in the petroleum industry, liquid-liquid extraction, education and professionalism and many other important subjects.

PLAN YOUR TRIP TODAY!

Hotel space is certain to be at a premium for this unusual show, so we suggest an early reservation. Contact the American Institute of Chemical Engineers, 25 West 45th Street, New York 36, N. Y. for details and further information.

For complete and up-to-date information on the latest petrochemical developments, you should become a member of the American Institute of Chemical Engineers. Just send in this coupon for full information.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS
25 West 45th Street, New York 36, N. Y.

Att: Membership Dept.

Please send me full information about the benefits of membership in the American Institute of Chemical Engineers.

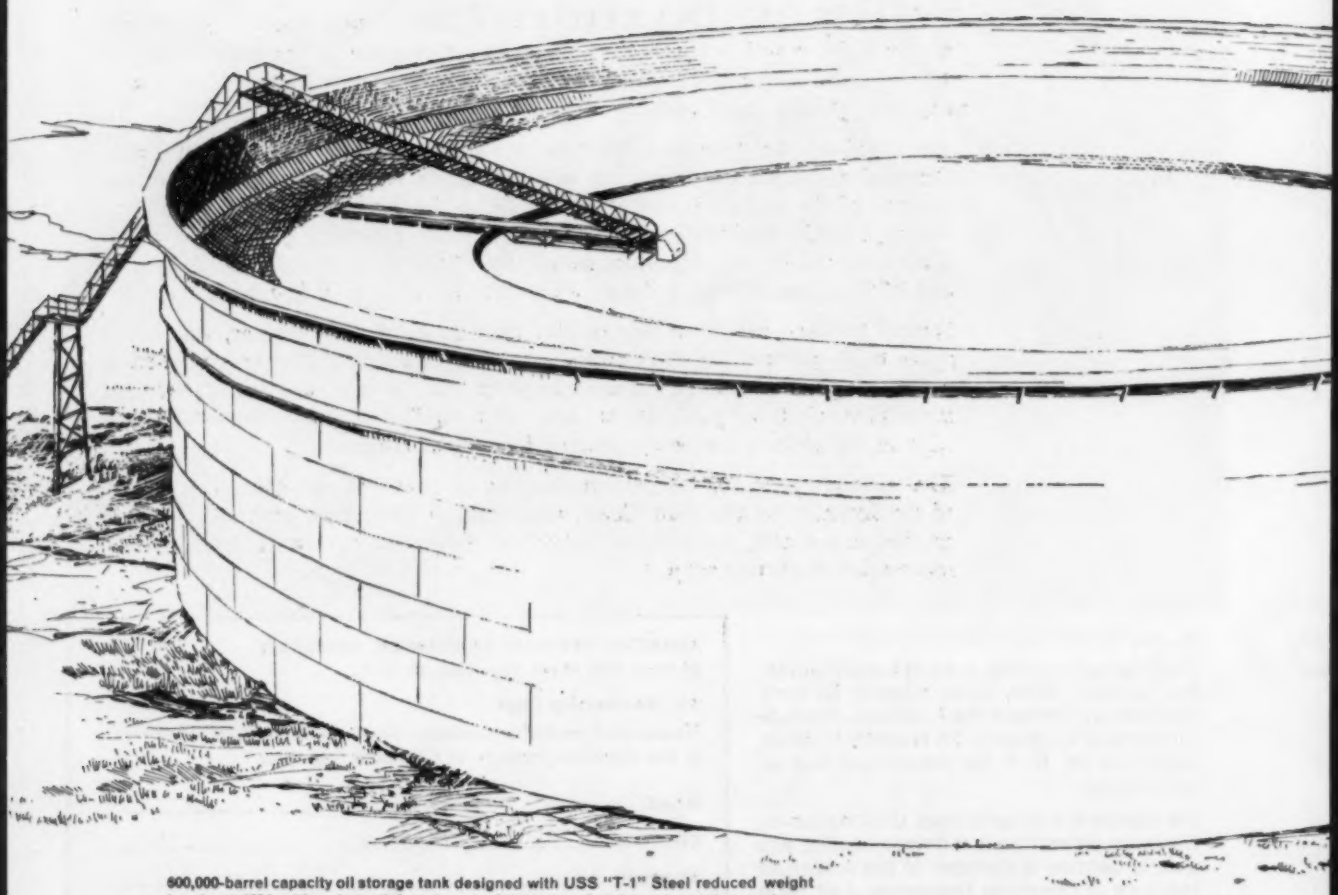
NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

World's largest oil storage tank built of



600,000-barrel capacity oil storage tank designed with USS "T-1" Steel reduced weight by about 42%, with substantial savings in fabrication, freight and erection costs.

This mark tells you a product is made of modern, dependable Steel.

USS "T-1" Steel

A new 600,000-barrel oil tank 260 feet in diameter and 64 feet high has been erected for the American Independent Oil Company in Mena Abdulla, Kuwait, on the Arabian Gulf.

Kuwait is a petroleum paradise. In 1957, its oil production amounted to 56,000,000 tons, and it is still increasing. Most of the oil is exported and a giant storage tank such as this makes it possible to fill one of the new super tankers in one stop, rather than several.

The Chicago Bridge & Iron Company obtained the contract for the tank with a design that took advantage of the *extra* high strength of USS "T-1" Constructional Alloy Steel and its many cost-saving features.

The shell consists of six 8-foot rings of "T-1" Steel, made to 115,000 psi minimum ultimate strength, and two top 8-foot rings made of A 131 grade A carbon steel. The tank has a Horton pontoon floating roof and the bottom of the vessel was made of A 283 grade C plates ¼-inch thick.

USS "T-1" Steel reduces weight. The "T-1" shell thicknesses, which ranged from 1 inch down to ½ inch, were determined on the basis of a design stress of 38,333 psi. This is ⅓ of the minimum ultimate strength of the steel. Joint efficiency was calculated at 100%, with a product specific gravity of 0.90. The top two carbon steel rings were figured for the API 12-C allowable stress of 21,000 psi, with 100% joint efficiency, and with a product specific gravity of 1.0. Steel thicknesses were ½ inch and ⅜ inch.

Although API prohibits the use of carbon steel plates in the thicknesses that would have been needed for the 6 lower rings, by using USS "T-1", 42% less steel was required. Fabricating, shipping, and erecting costs were thus considerably lower than original estimates.

Lower maintenance, too! USS "T-1" Steel has four times the resistance of carbon steel to atmospheric corrosion. Research has shown that paint life is greatly increased on steels of this nature.

Other applications. Because of USS "T-1" Steel's exceptional strength and toughness, even at very low temperatures, it is the ideal material for pressure vessels, equipment hauling trailers, LP gas transports, offshore rigs and other equipment that must be built stronger but lighter. Write for a copy of our booklet, USS "T-1" Steel. United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS and "T-1" are registered trademarks of United States Steel
"Horton" is a registered trademark of Chicago Bridge & Iron Company

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
National Tube—Pittsburgh
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Announcing!

A New Shaft Seal For Extremely Corrosive Service

TYPE 20

Made of DuPont Teflon

A new shaft seal to handle the most corrosive service conditions has been recently added to the John Crane line. Here's a seal that will stand up under all conditions of acids and salts, oxidizing agents and organic compounds.

It is so designed that all parts that normally contact the fluid are made of chemically-inert DuPont Teflon. Also, for this same reason it can be operated over wide temperature range up to 250° F.

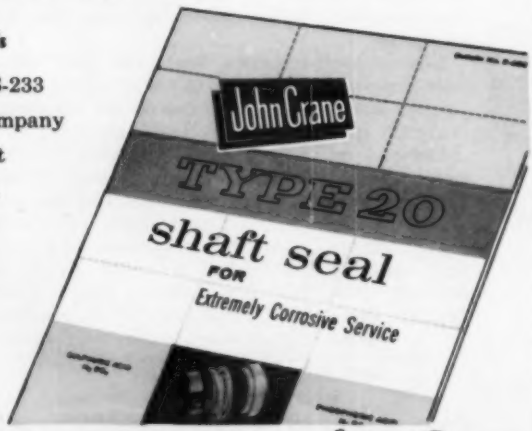
Mechanically, its bellows type construction readily adapts it for use in all non-abrasive slurry applications. It also compensates for extreme shaft run out.

Available in single face construction for internal or external mounting, double face for internal mounting.

Full range of shaft sizes from ⅛" to 3".

Get Complete Details

Request Bulletin S-233
Crane Packing Company
6429 Oakton Street
Morton Grove, Ill.
(Chicago Suburb)
In Canada:
Crane Packing
Company, Ltd.
Hamilton, Ont.

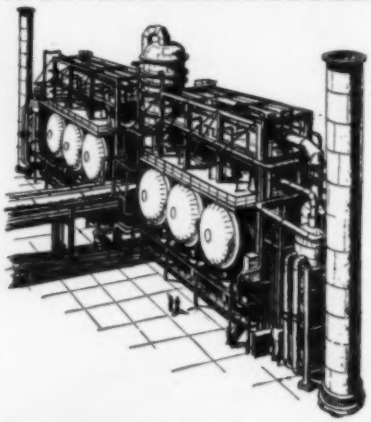


John Crane
MECHANICAL PACKINGS · SHAFT SEALS · TEFLON PRODUCTS · LAPPING MACHINES · THREAD COMPOUNDS

CRANE PACKING COMPANY

on stream in Japan

another
HOUDRY DEHYDRO PLANT



Japan Synthetic Rubber Co., Ltd.
Yokkaichi, Japan

This versatile installation is the first butadiene plant in Asia. It is designed to accommodate a wide variety of feed stocks ranging from straight run butane to complex mixtures from steam cracking operations. Design capacity is 25,000 ton/yr of butadiene from butane.

Houdry Dehydrogenation Catalyst is used in the reactors, which are arranged in two parallel systems. Either system of reactors can be operated independently of the other.

By direct dehydrogenation of butane, the Houdry Dehydrogenation Process can produce butene as well as butadiene, and produces other mono- and diolefins from the corresponding saturated hydrocarbons. Complete process description available on request.

*

HOUDRY

PROCESS CORPORATION

1528 Walnut Street, Philadelphia 2, Pa.

**Houdry means Progress . . . through Catalysis*

New B&W REFRACTORIES FOR THE PETROCHEMICAL INDUSTRY

B&W's line of refractories has been enlarged by the addition of new heavy duty firebrick and new ramming mixes. These new products, now offered after many years of developmental and field experience, are specifically designed for superior service in carbon black furnaces, butadiene reactors, reforming furnaces and vessels and other typical equipment used in petrochemical processing.

FIREBRICK

★

KAO-HB

HIGH BURNED SUPER DUTY FIREBRICK

Fusion point 3220 F. This brick offers an excellent balance of properties to assure superior service. It provides approximately 5% more alumina content and lower total impurities than competitive brick. It has excellent spalling resistance.

KAO 60

60% ALUMINA FIREBRICK

Fusion point 3250 F. Provides higher hot load strength than any competitive brick. Spalling loss is only 1%

KAO 70

70% ALUMINA FIREBRICK

Very low total impurities provide long life. Spall loss of only 2%.

RAMMING MIXES

★

MULRAM E

USE LIMIT 3200F
ALUMINA CONTENT–80%

This new ramming mix with extremely low permeability provides exceptional resistance to slag or molten metal penetration. High strength provides good erosion resistance.

MULRAM EF

USE LIMIT 3100F
ALUMINA CONTENT–80%

Similar to Mulram E but supplied in finer grain.

FOR COMPLETE PROPERTIES SHEETS and additional information on these new B&W Refractories products, write to The Babcock & Wilcox Company, Refractories Division, 161 East 42nd Street, New York 17, N. Y.

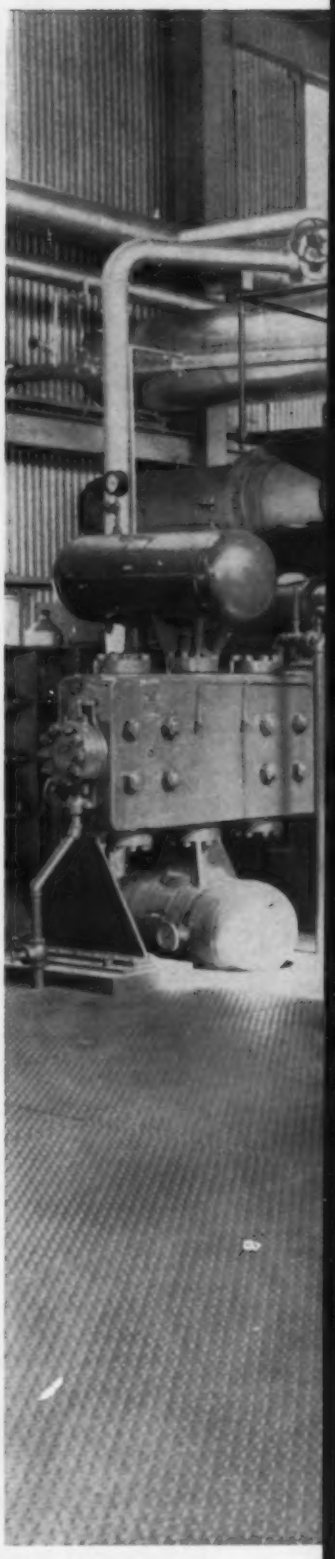
B&W

THE BABCOCK & WILCOX COMPANY

REFRACTORIES DIVISION

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.

Noel M. Champion *(left), Chief Engineer, Armour Agricultural Chemical Company, discusses a technical problem with* Robert L. Kietzman, *Sales Engineer, The Cooper-Bessemer Corporation, St. Louis District Office.*



How Cooper-Bessemer service helps keep the ammonia flowing

At Armour Agricultural Chemical Co., Crystal City, Missouri, nine Cooper-Bessemer compressors play key roles in the manufacture of ammonia products. Round the clock, for five years, these units have given exceptional performance under the rigors of such problems as handling pressures up to 9000 psi.

The performance of these C-B compressors has been backed by Cooper-Bessemer engineers in the St. Louis area and in Mt. Vernon, contributing helpful service for these high-pressure operations.

Cooper-Bessemer engineers will gladly help *you* plan compression facilities, and demonstrate how this unique service works for your benefit. Call the nearest office.

BRANCH OFFICES: Grove City • New York • Washington • Gloucester Pittsburgh • Detroit • Chicago • Minneapolis • St. Louis • Kansas City • Tulsa New Orleans • Shreveport • Houston • Greggton • Dallas • Odessa • Pampa Casper • Seattle • San Francisco • Los Angeles • *SUBSIDIARIES:* Cooper-Bessemer of Canada, Ltd. . . . Edmonton • Calgary • Toronto • Halifax Stratford • C-B Southern, Inc. . . . Houston • Cooper-Bessemer International Corp. . . . New York • Caracas • Anaco • Cooper-Bessemer, S.A. . . . Chur, Switzerland • The Hague, Netherlands • Mexico City • The Rotor Tool Company . . . Cleveland

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS • DIESEL • GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE, TURBINE OR MOTOR DRIVEN

Noel M. Champion *(left) and* Thomas H. Ferebee, *Supt. Ammonia Plant. In background are two GMWA-10, four GMWA-8 and one GMWA-6 engine driven compressors for compression of air, natural gas, synthesis gas and ammonia. Armour also has two FM compressors for ammonia recirculators.*

Here are symbolized the major processes for refining and converting petroleum to both intermediate and final products. Note that there is a superior UOP version of each one, along with eight other UOP processes not illustrated. Whatever your requirements...for processes, technical counsel or engineering service ...UOP can furnish whatever you may need.

PETROLEUM REFINING AND PETROCHEMICAL PROCESSES AVAILABLE FROM UOP

1. CRUDE DISTILLATION equipment is designed and engineered by UOP in any desired capacity.

2. VACUUM DISTILLATION and VISBREAKING—easy-to-operate processes for preparation of feed stocks for catalytic cracking.

3. FLUID CATALYTIC CRACKING—an improved process that gives higher yields, higher octane numbers.

4. LOMAX™—highly flexible process that converts middle distillates and vacuum gas oils into gasolines and distillate fuels of outstanding quality.

5. UNIFINING™—a modern process that completely purifies petroleum distillates.

6. PLATFORMING® produces high octane gasolines, high purity aromatics.

7. MOLEX™—a new continuous separating process that removes lowest-grade hydrocarbons from gasoline.

8. UDEX®—the ideal process for separation of super-purity aromatics.

9. BUTAMER™—a new and practical process for producing isobutane.

10. PENEX®—a new process that converts light, normal paraffins to isoparaffins.

11. HF ALKYLATION—makes alkylate, top anti-rumble motor fuel. Sulfuric acid process also available.

12. CATALYTIC CONDENSATION—converts olefin fractions of refinery gases into high-quality gasoline and petrochemicals.

13. MEROX™—a new and inexpensive treating process to remove mercaptans from gasolines and light distillates.

PROCESSES NOT ILLUSTRATED:

REXFORMING®—the ideal process to insure your top octane position.

CATALYTIC DEHYDROGENATION—removes hydrogen from hydrocarbons to produce less-saturated hydrocarbons.

HYDEAL™—a new process for the hydrodealkylation of toluene or C_8 aromatics to produce benzene; may also be used for manufacturing phenol and naphthalene.

HYDRAR™—converts benzene to cyclohexane with excellent yields, achieves extreme high purity with Udex grade benzene.

OLEFIN EXTRACTION—efficiently separates olefins and diolefins from paraffins; prepares olefins for further conversion.

AROSORB™—removes heavier aromatics from synthetic and natural distillates, produces aromatic-free heavier distillates.

ALKAR™—produces ethylbenzene, cumene and other alkylated aromatics from Fluid Cat Cracker off-gas streams.

UNISOL®—an economical process for treating high mercaptan-containing gasolines.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

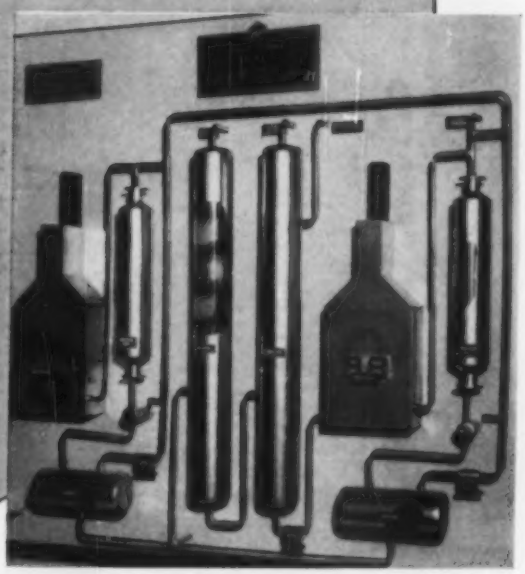
'62 COULD BE THE YEAR FOR YOU!

how to make products your customers want to buy...

Described below is the new and versatile UOP process . . . LOMAX. A remarkable and ultra-flexible cracking-with-hydrogen process, LOMAX enables the refiner to reach a new high in operating flexibility. He can convert his middle distillates into the most *immediately saleable* ratio of gasoline and distillate fuels . . . and change his ratio to fit the changing needs of his market.

With UOP processes the refiner can accomplish just about anything that comes within the realm of practical petroleum refining technology. Take a look at the brief descriptions on the opposite page, and you'll agree. And remember, in many cases existing equipment can be revamped and expanded, and thereby will produce more saleable products.

*INFORMED OPINION indicates that 1962 will require a substantial increase in process capacity ...NOW is the time to start your planning! Ask us about a preliminary proposal... no obligation!



LOMAX™ With this new and highly flexible UOP process, model of which is shown above, the refiner is able to increase production of his most currently saleable product on a year-'round basis. Through the catalyzed reaction of oil with hydrogen, LOMAX converts middle distillates ranging from kerosines to heavy gas oils into a wide ratio of gasoline or distillate fuels.

As seasonal demands change, LOMAX production of these products is adjusted accordingly.

Important additional benefits afforded by LOMAX include distillates of exceptionally high purity (even from sour crudes) . . . predominance of branched isomers in light hydrocarbons . . . greatly reduced quantities of light gases . . . olefin-free products . . . long catalyst life . . . and other advantages.

LOMAX may be used to supplement existing facilities, or as a basic cracking operation in a new installation.

UOP

UNIVERSAL OIL PRODUCTS COMPANY

30 Algonquin Road, Des Plaines, Illinois, U.S.A.

WHERE RESEARCH TODAY MEANS PROGRESS TOMORROW

. . . one of a series presented by Western Supply Company, Tulsa, to improve the "I.Q."* of engineers . . .
(*"Income Quotient")

"LOW FIRST-COST VS. LOW ULTIMATE COST" CONTROVERSY DEMANDS UNDERSTANDING OF ECONOMICS

In the price-economy of competitive bidding, especially in the field of capital process equipment, the historic struggle between long-range economy and "low-dollar" first-costs has been brought into sharp focus by modern cost engineering practices. Calculating and evaluating the eventual profitability of such equipment can no longer be a matter of "guestimates" or conjecture. The practical facts of economic life must be faced. Process companies must scrutinize closely **ALL** the factors concerned in engineering, construction, installation and **continued operation.** Unanticipated maintenance or replacement costs can quickly increase the cost of operation, and supposed first-cost savings are thus virtually or entirely eliminated.

Why is "cost engineering", or engineering economics an exotic term to most engineers? This is the **Age of Specialization,** and so it follows, given free rein, over-design frequently occurs. At the other extreme is the "gimmick pushers" approach that anything will suffice if the price is right. Between these two extremes the dedicated engineer must establish parameters that will satisfy to the highest degree the three M's of industry — **Men, Materials, and Means.**

Faced with these problems, then, how can we best solve the problem: "When is a low bid really low?" A multitude of answers must contribute to the total solution. What is the longevity of the equipment? How many spare parts will be required? How often will shut-down be required to make repairs? How much time will be required? What are the economic consequences of shutting down the continuous flow operation?

Cost-and-economy consciousness is of prime concern in each stage of process equipment manufacture — from design through fabrication, and finally to installation and operation. All aspects of true costs must be considered, not simply those which are obvious at the moment.

Infinite care must be exercised when considering the following:

Design — a major factor involved in the creation of process equipment. During the design phase, the greatest waste often results from a desire to be conservative. True economy in design must, therefore, satisfy the criteria which apply to each particular process.

Payout — management is interested in equipment that will pay out in the shortest period of time, and this would seem to indicate buying only what is required, at the lowest cost, at the time it is needed. Again, however, the life of the equipment, its maintenance, shut-down time and other factors cannot be ignored.

Excess-capacity — each piece of equipment must be designed for its specific use in order to obtain maximum benefit of capital dollars. Excess-capacity equipment, purchased without specific anticipation of future expansion, represents idle investment dollars.

Today's fierce competition requires the concentrated application of both short and long term economies, from design through final construction and operation. **This subject is treated in more detail in a new booklet, "Low Ultimate Costs and Low Dollar Bids Are Not the Same", and single or multiple copies are available by writing WESTERN SUPPLY COMPANY, P. O. Box 1888, TULSA, OKLAHOMA . . . where the teamwork of science, engineering, technology and economics are combined to provide the optimum in the "cost-engineered" heat exchangers in your future.**

PETRO/CHEM new equipment

Algebraic compiler makes computer programming easy

ALGO algebraic compiler will allow anyone with knowledge of high school algebra to program engineering problems as they are being analyzed. Uses a universal language programming system closely parallel to algebra. Self-teaching manual makes previous knowledge of computer and programming technique unnecessary. Available to Bendix G-15 users. *Bendix Computer Division.*

Circle number (41) on reply card.

New chart integrator

Integrator for use with both strip charts and conventional instrument round charts not only computes chart extension for differential and static pressure, but also provides read-out values for the average absolute static pressure and the average differential pressure. Records are easy to check as follower-pens superimpose a light ink line on the original chart record. *American Meter Company.*

Circle number (42) on reply card.

Pressure reducing valves

Pressure reducing valves with capacities of 50,000 lb per hr of steam or 2500 gal per min of water are made in 4 and 6-in. sizes. Suitable for pressures to 250 psi and temperatures to 500F. *OPW-Jordan Corporation.*

Circle number (43) on reply card.

Bi-metal dial thermometers attach magnetically to steel

Magnetically attaching bi-metal dial thermometers for temperature measurement on ferrous materials come in temperature ranges from minus 60 to plus 700 F and have accuracies of better than 2%. Available in three styles: for temperature measurement only, with maximum reset hand, and with electric contactor to permit "on-off" temperature control with electric resistance or induction heating. *Industrial Service Co.*

Circle number (44) on reply card.

Penton-lined diaphragm valves

Eight-in. flanged Penton-lined packless diaphragm valve is available with cast iron or aluminum body and with a wide variety of diaphragm materials. Costs less than solid Penton or various corrosion-resistant metal valves but provides comparable or superior resistance to a wide range of chemicals. Suitable for maximum pressure of 100 psi and temperatures to 240, depending upon pressure. *Hills-McCanna Company.*

Circle number (45) on reply card.

Electroless nickel plating

Snap-Tite quick-disconnect couplings can now be protected by electroless nickel plating to provide virtually the same protection against corrosion previously guaranteed only by stainless steel, but at a considerably lower cost. Abrasion resistance is good, and plating process does not effect tensile strength or ductility of steel in the couplings. *Snap-Tite, Inc.*

Circle number (46) on reply card.

Thermal insulation also serves as fireproofing

Calsilite-Hi is new thermal insulation that withstands soaking heat up to 1800 F . . . has added advantage of being an industrial fireproofing material. Is a calcium silicate compound combined with asbestos fibers and other materials. Available in half sectional, three segmental, and block form. Resists most chemicals and alkalis in industrial concentrations. *The Ruberoid Co.*

Circle number (47) on reply card.

Instrument measures wall thicknesses ultrasonically

Sonizon SO-300, completely transistorized battery-operated ultrasonic instrument, measures wall thickness between .025 and 2.50 in. Is useful for detecting corrosion or wear in tanks or piping. *Magnaflux Corporation.*

Circle number (48) on reply card.

Gas detection instrument guards against explosions

Detectogas air density monitor detects both lighter and heavier-than-air gases . . . activates alarm or control circuit. Uses a mechanical balance principle which enables it to operate around the clock without an attendant and without power. Is not affected by changes in temperature, humidity, and pressure. *Detectogas Instruments, Inc.*

Circle number (49) on reply card.

New adapters will convert manual valves to automatics

By removing valve stem and bonnet from existing valve body and installing in their place a remote control valve adapter, any manually operated piping system may be given modern automatic control. No uncoupling or repiping is necessary. Adapters may be either electrically operated (Model 28E) or hydraulically operated (Model 28H) and are available for converting most of the standard globe valves now in use. *Febco, Inc.*

Circle number (50) on reply card.

Extreme pressure additive

Extreme Pressure Additive 1 is designed specifically for use in automotive trans-axle fluids, in gear oils, and in industrial cutting oils. Addition of EPA-1 to a conventional automatic transmission fluid enables it to meet the extreme pressure requirements of rear axle hypoid gear oils. In gear oils it imparts desired load-carrying capacity for protection against gear wear under both high-speed and high-shock loading conditions. *Ethyl Corporation.*

Circle number (51) on reply card.

Computer controller stabilizes fractionating tower operation

Internal reflux computer, new fractionator control system, prevents column upsets due to effect of ambient-temperature changes on external reflux. It computes internal reflux flow from measurements of the external-reflux flow rate and the difference in temperature between overhead product and the external reflux. It maintains a constant internal-reflux flow by regulating a valve on the external-reflux stream. *Swartwout Division, Crane Co.*

Circle number (52) on reply card.

New high-temperature lube oil and grease additive

UOP-225 is new additive to combat high-temperature deterioration of lubricating oil and reduce bearing corrosion. Contains no metal or phosphorus. Stable at temperatures above 500 F and leaves no combustion ash. Completely soluble in petroleum and synthetic lubricants. *Universal Oil Products Company.*

Circle number (53) on reply card.

WE HAVE DESIGNS ON EVERYBODY'S CHARGE STOCK

Serving processors who want high yields of high octane gasoline begins at Houdry, with three efficient and flexible catalytic processes.

The HOUDRIFLOW Process accepts in liquid or vapor form any fraction between naphtha and asphalt from both sweet and sour crudes. In the HOUDRESID Process, reduced crudes are converted into high octane gasoline and light distillate fuel—without production of heavy residual fuel.

Straight-run and cracked petroleum naphthas are converted to high octane gasoline, blending stocks, and aromatics by the efficient HOUDRIFORMING and ISO-PLUS HOUDRIFORMING Processes.

Complementing these processes, Houdry also offers catalysts, technical service, engineering, research, and economic consultation.

Write, outlining your interests or requirements, for a full description of specific ways Houdry may be able to serve you.

*HOUDRY

PROCESS CORPORATION
1528 Walnut Street, Philadelphia 2, Pa.
*Houdry means Progress...through Catalysis

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

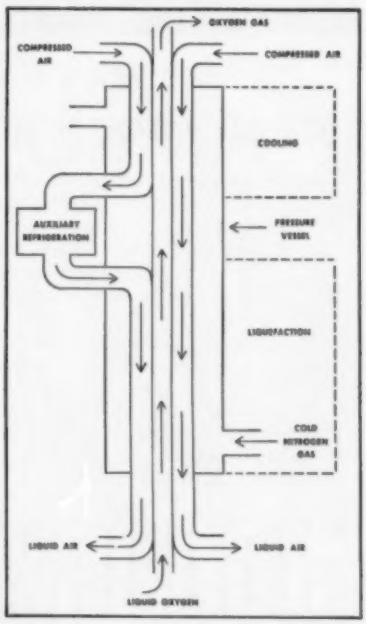
CONDENSER AND HEAT EXCHANGER CLINIC

Edited by Arthur W. Tracy, Metallurgical Engineer
Anaconda American Brass Co., Waterbury, Conn.

Cryogenic heat exchanger uses 16 miles of copper tube

A copper-tube heat exchanger used in the production of oxygen and nitrogen in a large low-temperature processing plant made by AIR PRODUCTS, INC., Allentown, Pa. The ⅜" tubes are wound tightly and built up layer by layer for greatest possible surface contact – and maximum heat transfer between the oxygen and air tube systems (see diagram below). AIR PRODUCTS winds bundles from long lengths of Anaconda tube. A total of 85,200 feet is used in this exchanger, for a total weight of 14,500 pounds. The "button-hook" manifolds for the tube systems are of Red Brass pipe, with extra-heavy or double-extra-heavy wall.

In applied cryogenics – the use of low-temperature techniques for gas liquefaction and separation and for the handling and application of these gases – the unique properties of copper and copper alloys become particularly important. The high thermal conductivity of copper – the highest of any commercial metal – is essential for economical heat transfer in large volumes of fluids. Outstanding corrosion resistance is important. And finally, copper has no tendency to brittleness at very low temperatures, and the strength of copper and copper alloys is significantly higher at –300F than at room temperature.



Schematic diagram of heat exchanger used in the production of oxygen and nitrogen. Incoming air under pressure passes through a set of coils in the exchanger and is cooled by counter current heat exchange by cold outgoing oxygen and nitrogen. Oxygen from the distillation column enters the heat exchanger as a liquid under pressure and, in removing heat from the air, vaporizes to a gaseous form and leaves the heat exchanger at near entering air temperature. Part way through the heat exchanger, the air is removed from the heat exchanger and sent through a Freon cooling system for auxiliary refrigeration and then returned to the exchanger for final cooling.

The use of low-temperature processing and of liquefied gases is rapidly increasing in the chemical industry, in basic metals industries, and in space and missile fields. And new applications are being found constantly. Anaconda American Brass Company specialists are available to help select the alloy best suited to your job. For more information on tubes for heat transfer, or for technical assistance, write: Anaconda American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 60681.

ANACONDA®
TUBES and PLATES for
CONDENSERS & HEAT EXCHANGERS
ANACONDA AMERICAN BRASS COMPANY

Plant noise no obstacle with this communication system

New Telepath industrial wire communications system provides intelligible communications under any noise conditions, including jet engine type noise. Uses transistorized amplifiers in combination with a variety of earphone/microphone headsets to form "wearable" units for almost any type of operation requiring wired person-to-person communications. *Seiscor Division, Seismograph Service Corp.*

Circle number (54) on reply card.

Potentiometer controller is thermocouple operated

Ease of operation is a major feature of new low-cost thermocouple-operated potentiometer. Temperature adjustments are made by turning dial on the cover of the transistorized amplifier-relay. Transparent window makes settings easy to read. Temperatures are sensed through use of a heat sensitive thermocouple inserted into the medium to be controlled. Temperatures from minus 200 to plus 2000 F can be controlled to within four degrees. *Minneapolis-Honeywell Regulator Co.*

Circle number (55) on reply card.

Water-powered tank cleaner is light-weight, versatile

Model "H" tank cleaner weighs just 42 lb (64 lb when stand is used), and can be used with either two or four nozzles. Nozzles rotate in both the horizontal and vertical planes simultaneously, providing a thorough washing pattern inside tank or vessel. Unit operates effectively at pressures from 28 to 170 psi and temperatures up to 203 F. Capacity range is 3800 to 8500 gal per hr. Performs effectively in any position, whether suspended from the end of a hose or on a special folding stand. *Sellers Injector Corp.*

Circle number (56) on reply card.

Spline-coupled hydraulic pump motors almost 3-in. shorter

New line of Tri/Clad 55 spline-coupled hydraulic pump motors is available in NEMA frame sizes 182, 184, 213, and 215. Motors are almost 3 in. shorter than those of the open-adapter design introduced earlier. Shorter length is particularly significant when pumps are mounted on both ends of the motors. Furnished with coupling splined on the motor end and conventional bore and keyway on pump end. Will accept wide variety of pump designs. *General Electric Company.*

Circle number (57) on reply card.

Impactor handwheels standard equipment on 600-lb valves

Impactor handwheels are now standard equipment at no extra cost on all Edward 600-lb cast-steel hand-operated valves. They permit tighter closing than conventional handwheels by multiplying the closing torque attainable with ordinary handwheels up to 2½ times. *Edward Valves, Inc.*

Circle number (58) on reply card.

Non-lube air compressor

New non-lube balanced/opposed air compressor, driven by a flange mounted electric motor, is designed for continuous heavy duty service in applications where lube oil contamination of the air stream cannot be tolerated. Piston rings and piston rod packing in the compressor cylinder are made of self-lubricating Teflon, which will not break under normal handling as is often the case with carbon pistons and rings. Compressor cylinder is isolated from the main compressor lubrication system. Built in four sizes rated at 75, 100, 125, and 150 bhp. *Clark Bros. Co.*

Circle number (59) on reply card.

CHECK THESE
FACTS
on the World's Newest, All-In-One Coupling
for making hose connections at dockside, shipboard, storage depots, off-shore rigs, bunkering stations, and with road and rail tankers, etc.*

✓ **SAFE** Eliminates gaskets, drifts and wrenches and the dangers associated with their use.

✓ **EASY TO OPERATE** Just hook up and rotate the handle.

✓ **VERSATILE** Can be easily adjusted to accommodate the variations found in foreign counterparts of American flanges; can be attached to the hose either by screwing directly to the threaded nipple in the hose or by bolting to an existing hose flange.

✓ **POSITIVE SEALING** The seal is automatically made as the flanges are brought together and even on the roughest surfaces, the *higher* the pressure, the *tighter* the seal.

✓ **POSITIVE LOCKING** The coupling is locked whenever handle rotation is stopped.

**To check ALL the facts on construction and operation, request on your letterhead: "QD-16 Coupling Brochure"*

Flight Refueling, Inc.
COMMERCIAL PRODUCTS SECTION BOX 1701 BALTO. 3, MD.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PETRO/CHEM newsmakers

▸ Major personnel changes affecting three of Gulf Oil Corporation's U. S. refineries:

R. J. Metcalf, formerly manager-operations, Philadelphia refinery, promoted to general manager of the Cincinnati refinery.

Paul Siecke, who was Cincinnati refinery manager, transferred to Gulf Eastern Company, London.

W. S. Bonnell, formerly director-chemical processing division, Port Arthur refinery, promoted to manager-operations at Philadelphia.

Eric B. Hjerpe, who was director-operations planning and scheduling division, Port Arthur, named director-chemical processing division, Port Arthur.

▸ **George H. Unzelman** has been named chief refinery technologist for the western region of Ethyl Corporation. He will make his headquarters in Los Angeles.

▸ **Olaf A. Hougen,** professor of chemical engineering at the University of Wisconsin, has been awarded an honorary doctor's degree at Technical University of Norway, Trondheim.

▸ **W. W. Clark,** Houston, has been promoted to special assistant to the general manager of Continental Oil Company's petrochemical department and also will serve as assistant to the chairman of the board of Carlon Products, Inc., Aurora, Ohio, a Conoco affiliate. He will make his headquarters at Aurora, some 14 miles southeast of Cleveland.

▸ Promotions in the process development laboratories at American Oil's Texas City refinery:

Karl A. Muller, to senior chemical engineer.

Clifton N. Sechrist, to senior chemist (group leader).

Manford R. Haxton, to chemical engineer (group leader).

P. J. Naquin, to associate chemical engineer.

In plant engineering, **Marion B. Sterling** has been promoted to associate construction and maintenance engineer.

▸ **Dr. Raymond Wynkoop** has been appointed director of a newly organized commercial development division in Sun Oil Company's research and engineering department.

Dr. Egbert M. Kipp has succeeded Wynkoop as manager of basic research.

▸ Engineers recently appointed to key posts at Mobil Chemical Company's Beaumont, Texas, installations include **R. B. Thompson,** manager, technical department; **R. E. Turkleson,** manager, production department, and **W. E. McKeller Jr.,** manager, employee relations department.

▸ **Rexford S. Blazer,** Ashland Oil & Refining Co., Ashland, Kentucky, has been re-elected to a second term as president of the National Petroleum Association.

▸ **Warren O. Carlson** has joined the consulting firm of BEACO, Ltd., Montreal, Canada, as vice president in charge of the refining division and will be responsible for all the company's activities in the petroleum refining, petrochemical, and gas processing fields. He will establish his offices in Calgary, Alberta. He formerly was with C. W. Nofsinger Company, a consulting engineering firm in Kansas City, Missouri.

▸ **C. J. Livingstone** has been named associate director of research in charge of product research, development, and testing of Gulf Research & Development Company, Pittsburgh.

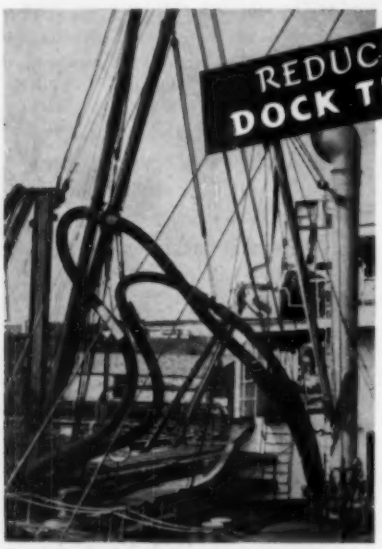
▸ **Eugene Moriarty** has been elected an assistant vice president-new projects for Scientific Design Company, Inc., New York. He previously was manager-new chemical projects for Vitro Engineering Company.

▸ **Dr. James H. Gary** has been named head of the petroleum refining department and named full professor at Colorado School of Mines, Golden. He formerly was an associate professor at the University of Alabama.

▸ Technical division appointments at Humble's Baytown, Texas refinery:

D. R. Moore, supervising engineer.

R. J. Davis and **R. C. Wahrmund,** staff engineers.



Paranite Loading Hose for years has been recognized for long service.

Furnished in 7 types, smooth-bore, rough bore, for sea and dock ship loading and for barge service.

Ask about R/M Rotary Hose, Mud Pump Intake Hose, Vibration Hose, and Non-Bursting Steam Hose.

WITH PARANITE LOADING HOSE

- Hycar Tube—High-Octane Resistant
- Uniform Bore Assures Rapid Flow—Suction and Discharge
- Oil, Abrasion and Weather Resisting Neoprene Cover
- Type "C" Built-in, Leakproof Fittings
- 7 Types for Pressures to 200 psi.

RM 1047

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY
ENGINEERED RUBBER PRODUCTS.. MORE USE PER DOLLAR

RM

MOVING to a New Address?

If you are moving or expect possibly to move any time soon, save the coupon below for your convenient change of address. It will prevent your copy of Petro/Chem Engineer from being lost or mis-directed.

TO: Petro/Chem Engineer
P. O. Box 1589 • Dallas 21, Texas

Change my address, beginning with the_____issue

FROM: _____

_____

_____

TO: _____

_____

_____

for LEAKPROOF PRESSURE-TITE Connections...

TiteSeal
SEALING COMPOUNDS

Heat and vibration-proof, non-solvent, will not shrink, crack or crumble. Makes all assemblies leak-proof and pressure-tight. Prevents rust, corrosion and joint seizure.

7 BASIC BLENDS

LIQUID WRENCH

LOOSENS RUSTED BOLTS

A powerful blend of fast-acting solvents that literally "melt the rust away" —safe on all metals and alloys.

RADIATOR SPECIALTY CO.
CHARLOTTE, N. C.

▸ **Gerald Fisher,** pollution control coordinator of Mobil Oil Company who is widely known for his contributions to the oil industry's air pollution abatement program, is retiring after 37 years' service with Mobil.

▸ **Charles O. Peyton** will serve as manager of industrial and consumer sales for Esso Standard division, Humble Oil & Refining Company, while continuing to head Esso's petroleum specialties department.

Peyton succeeds **Charles W. Bohmer Jr.** who has joined the headquarters organization of the Humble company in Houston as assistant to **D. Woodson Ramsey Jr.,** vice president and director for marketing.

▸ **Paul Kimbrell Smith Jr.** is now a staff engineer in the natural gasoline department of Kerr-McGee Oil Industries, Inc., Oklahoma City. He formerly was plant foreman for Mobil Oil Company at Smackover, Arkansas.

▸ **Thomas Charles** is now director of purchases for Catalytic Construction Company. Formerly chief estimator for Catalytic, he recently completed an assignment as a special representative to the company's Paris affiliate, Compagnie Francaise d'Etudes et de Construction TECHNIP, where he established the purchasing, estimating, and cost control departments.

▸ **Howard E. Padgett,** Baytown, Texas, has joined Crawford & Russell, Inc., Stamford, Connecticut, as construction manager, southern division. He previously was a construction superintendent for M. W. Kellogg Company.

A DURAMETALLIC PACKING Specifically Designed for HOT

pumps and valves on temperatures up to 1000° F... Durametallic Type D-10 is a twisted flexible aluminum foil packing that will give superior sealing in the presence of high pressures and temperatures... unaffected by organic compounds ...supplied in spiral or die-molded rings.

OILS
ASPHALT
TAR
PARAFFIN

BY THE MAKERS OF DURA SEAL — The PERFECT SEAL — THE ENGINEERED MECHANICAL SEAL

DURAMETALLIC CORPORATION
KALAMAZOO MICHIGAN

Choosing an Antioxidant?

DALPAC® 4 SAVES YOU MORE

Refinery customers have found that, in comparison with other inhibitors, Dalpac 4 (Hercules 2,6-di-tert-butyl-p-cresol) saves up to three dollars on every thousand barrels of gasoline produced. Dalpac 4 inhibits gum formation, stabilizes gasoline color, and helps maintain engine cleanliness. Refiners have also found it to be excellent in turbine and transformer oils where it prevents deterioration, and does not affect electrical properties.

For additional information write:

Oxychemicals Division
Naval Stores Department
HERCULES POWDER COMPANY
900 Market Street
Wilmington 99, Delaware

N059-5P

REPAIR PIPE LEAKS

QUICKLY PERMANENTLY

ANY PRESSURE
ANY TEMPERATURE

SKINNER·SEAL
EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

SKINNER·SEAL
COLLAR LEAK CLAMPS—for oil and gas lines. Gasket is sealed by gasket container rings—pressure is sealed in . . . air, moisture and gasket-destroying soil conditions are sealed out. Effective under any pressure. Sizes 2"—13" O.D. incl. In stock at oil supply stores!

For over half a century, a complete line of Repair Clamps and Saddles for steel and cast iron pipe. Send for catalog!

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

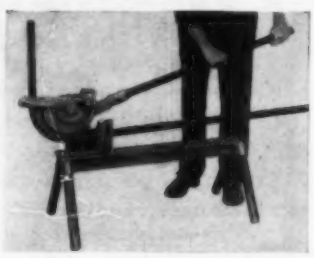
FAST, Lightweight
Greenlee Hydraulic Benders for 1/2"-4" Conduit and Pipe

full 90° bend with one ram stroke

NEW GREENLEE No. 883 Lightweight Hydraulic Pipe Bender quickly makes accurate bends in eight sizes of pipe from ½" through 3" . . . up to 90° with one ram stroke. Operates with either a portable power pump or hand pump. Makes 90° bend in 3" pipe in approximately 1 minute with power pump . . . only 10 minutes with hand pump. One set of rotating supports for all eight pipe sizes . . . supports also serve as rollers for wheeling bender from job to job. Pipe is easily inserted and removed from front of bender. "Quick-removal," positive-locking support pins cannot come loose. Bending gauge included for accurate results with minimum calculations. Get details now on the complete GREENLEE Lightweight Bender line that includes three models for ½" - 2" . . . ½" - 3" . . . and ½" - 4" pipe.

new, fast ratchet bender for ½", ¾", 1" pipe

GREENLEE No. 1800 Ratchet Hand Bender permits short, powerful strokes for easy, quick bending up to 90°. Swing-away clamp makes loading simple. Sturdy T-iron base sets anywhere or receives threaded pipe legs of any desired length. Built-in bending gauge reads 0 to 90°. See your distributor for a demonstration, or write for descriptive Bulletin E-291.



A COMPLETE LINE OF HYDRAULIC AND HAND BENDERS FOR PIPE AND TUBING

GREENLEE TOOL CO.
1757 Columbia Ave., Rockford, Illinois

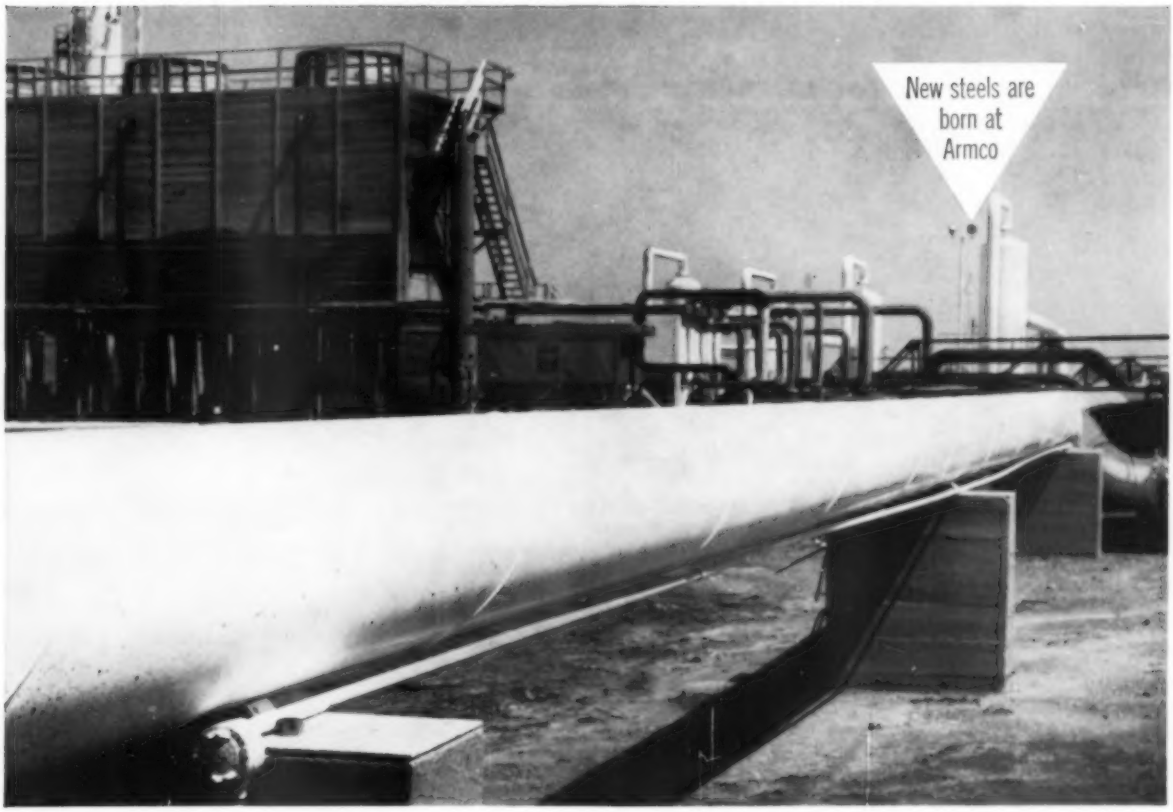
GREENLEE

PIPELINE Engineer

Special Construction Report

SPECIFY ARMCO LINE PIPE

for the strength you want in the sizes you need



Armco Line Pipe has extremely low residual stress — about 90 per cent less than in many commonly used standard pipes. This greatly reduces the danger in unforeseen overloads. Tests regularly made on Armco Line Pipe, in accordance with standard steel pipe specifications, are your assurance that Armco Pipe will meet your strength requirements every time.

You get the exact sizes you need with Armco Line Pipe because you have 132 different diameter-wall thicknesses to choose from. And because Armco Pipe is supplied in lengths up to 50 feet, there are fewer field joints, less welding and handling time.

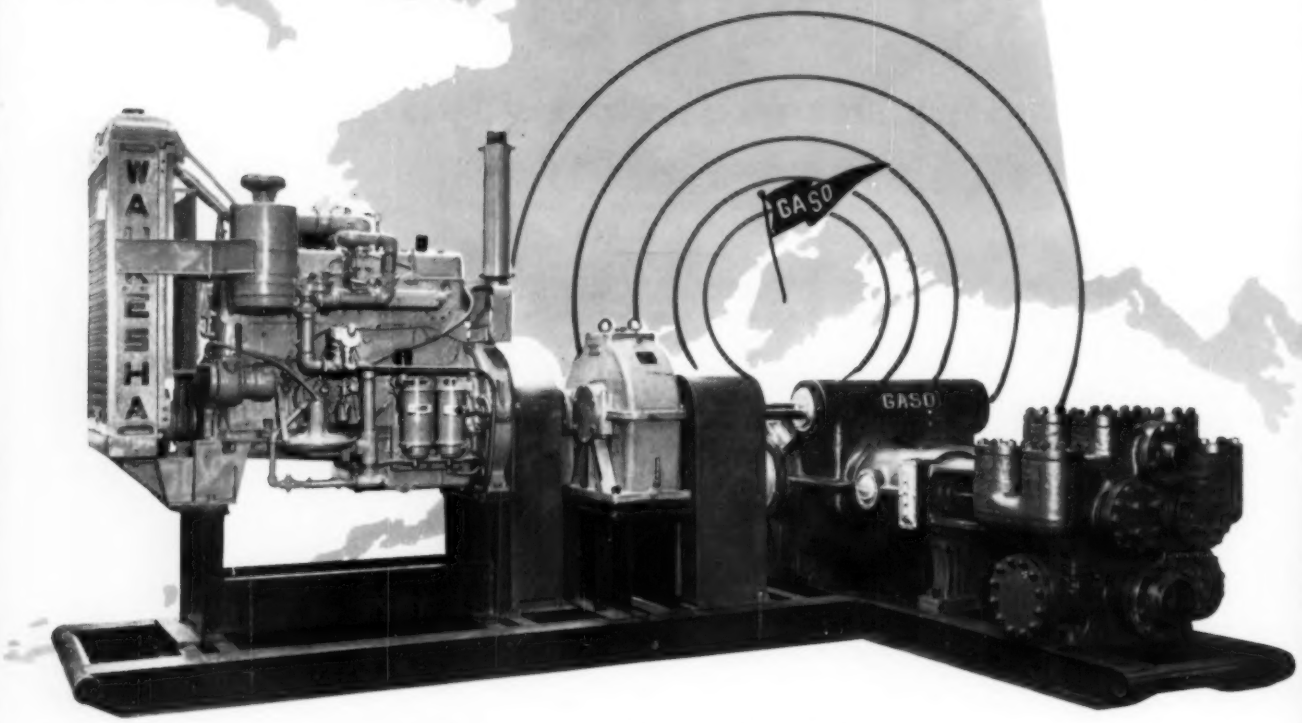
Write us for complete information on Armco Line Pipe. Armco Drainage & Metal Products, Inc., 6520 Curtis Street, Middletown, Ohio, or 201 KOME Building, Tulsa, Oklahoma.

ARMCO DRAINAGE & METAL PRODUCTS

Subsidiary of ARMCO STEEL CORPORATION

OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company • The Armco International Corporation • Union Wire Rope Corporation

DESTINATION:
KENAI PENINSULA, ALASKA



GASO PUMPS BRING GASO PERFORMANCE TO THE 49TH STATE

The photograph shows one of two Gaso Pumping Units delivered to the Kenai Pipe Line Company. The assembly consists of a Gaso Figure 2651, 5½"x12" Horizontal Duplex Piston Power Pump direct connected through a Lufkin 4.25 to 1 gear reducer to a Model 6-WAKBU Waukesha Oilfield Power Unit.

Normal operation calls for 435 barrels of crude oil per hour—10,440 barrels per day—at 500 pounds discharge. Under emergency conditions the pump will deliver the fluid at 950 pounds discharge.

The world-wide preference for Gaso Pumps stems from performance that speaks a language all pipe line engineers understand—a language of completely dependable service for longer periods of time, with less maintenance, all adding up to greater returns on the pumping investment.

SEND FOR OUR 1960-61 CATALOG

GASO PUMPS *for every oil industry need*

DISTRIBUTORS

Farmington, N. M.— Gaso Pump & Burner Mfg. Co. • Shreveport, La., Odessa, Texas, Brookhaven and Tinsley, Miss.— W. L. Somner Company • Houston, Texas — Texas Pump & Compressor Company • Wichita Falls, Texas — Pump Engineering Co. • Evansville, Ind.— Hague Equipment Co., Inc. • Long Beach and Bakersfield, Cal.— Power Pumps, Inc. • Casper, Wyoming — Lufkin Foundry & Machine Co. • Edmonton, Alberta — Lufkin Machine Co., Ltd.

GASO PUMP & BURNER MFG. CO. First and Lansing Streets, Tulsa Oklahoma • Export Office: Empire State Building, New York, N. Y.

This Colorado Interstate Dispatcher is reading gas flow data from four different states...

Foxboro "packaged" gas flow computer located at metering station in South Colorado Springs. Differential and static pressure instruments (right of panel) convert measurements to electrical inputs for the Dynalog* Computer-Telemeter (lower left). Instrument at upper left telemeters down-stream gas pressure.

Foxboro Gas Flow Computing Systems deliver it continuously, automatically

Continuous gas flow totals from 20 metering stations, scattered across four Rocky Mountain states. That's the information Foxboro Gas Flow Computers provide for Colorado Interstate Gas Company in Colorado Springs.

Foxboro Gas Flow Computers do their computing at the metering point. Compensation for temperature and pressure is done on the spot with only total gas flow values being transmitted. Result: transmission line space is saved; errors common to systems that transmit several values are reduced.

Foxboro Gas Flow Computers are furnished as a complete "packaged" unit — calibrated and tested as a system before shipment — ready to install.

For single meter runs — for multiple runs, you can't beat the accuracy or the reliability of this Foxboro system. Ask your local Foxboro Field Engineer for details.

The Foxboro Company, 3811 Norfolk Street, Foxboro, Massachusetts. *Reg. U. S. Pat. Off.*

FOXBORO

REG. U.S. PAT. OFF.

SUPER-INCH MONEY-MAKER

Allis-Chalmers 225-hp HD-21 has the power, side boom capacity and over-all strength to make money for you on the biggest pipe—and the over-all design superiority to do it in any kind of terrain.

Pipeliners are using Allis-Chalmers HD-21 side boom crawlers to handle the biggest pipe loads; 34-in., 36-in., 42-in.—and heaviest of all—the concrete-coated pipe. And these big-capacity machines not only move right along with the super-inch stuff, but they also work profitably on medium-inch lines.

When you consider your next pipeline tractor spread, look at every factor—original cost, fuel consumption, ease of maintenance, life of components, over-all performance, nationwide dealer service—and you can look to Allis-Chalmers for your best tractor buy.

Note the rocky, abrasive ground in this picture. There's just one track that's made-to-order for this rough stuff—that's Allis-Chalmers. Special steels that are specially heat-treated make these track shoes, side bars, track pins and bushings the industry's toughest.

One last point. Pipeliners say nothing matches an Allis-Chalmers side boom tractor for flotation and maneuverability in muddy, swampy going. A tractor that's dependable in mud is good anywhere. Your Allis-Chalmers construction machinery dealer is eager to prove it with a demonstration. He is also in a position to give you the best possible terms. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

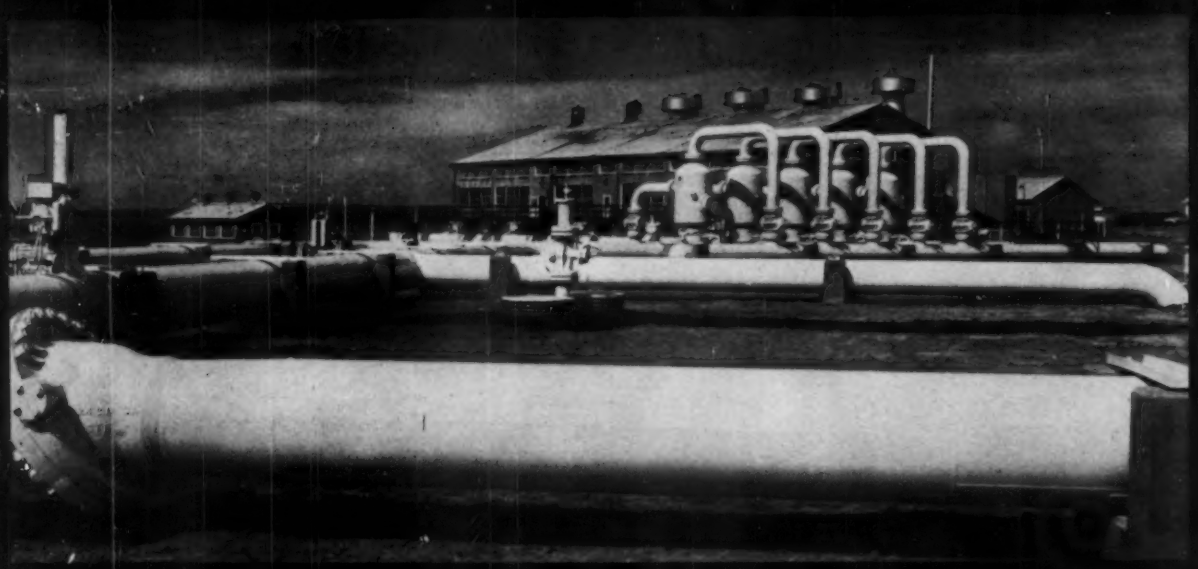
HD-21
Crawler Tractor

- *225 net engine hp*
- *Hydraulic torque converter drive*
- *Bare tractor weight: 46,200 lb (long track model)*
- *Weight with side boom: 79,050 lb*
- *Side boom lifting capacity: 127,000 lb at 4 ft*

move ahead with
ALLIS-CHALMERS
power for a growing world

VETERANS OF THREE YEARS OF TOUGH PIPELINING. These HD-21's are three years old and still going strong. Owner reports, "These tractors have been steady, dependable performers under tough operating conditions."

THREE GENERAL ELECTRIC GAS TURBINES in this petro-chemical plant run continuously, demonstrating General Electric gas turbine reliability.

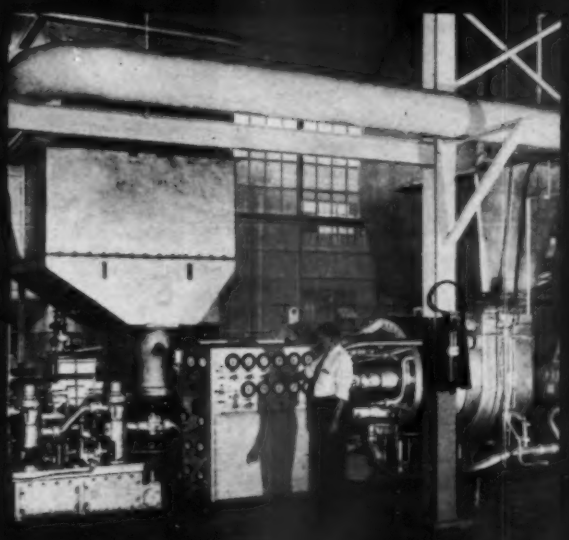


OVER FIVE YEARS OF DEPENDABLE OPERATION and still going strong. The record of the four units in this gas pipeline compressor station underscores the high availability-reliability characteristics of General Electric gas turbines, including 200 installed units.

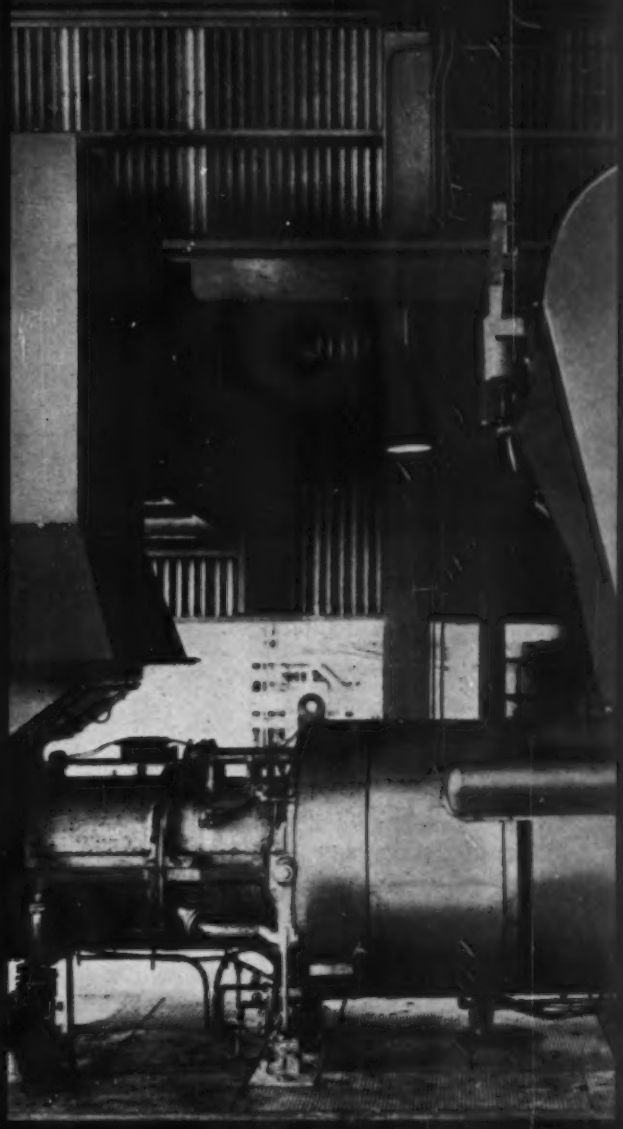
You're assured of General Electric gas turbine reliability backed by this operating performance:

200 operating gas turbines
1,600,000 installed horsepower*
4,000,000 hours, or
450 machine-years of operation

ON THE ARABIAN DESERT, six unattended pipeline pumping stations powered by reliable General Electric gas turbines are being radio-controlled from fifty to one hundred miles away.



THIS DUAL-FUELED UNIT is providing dependable generating capacity and at the same time further contributing to plant efficiency by exhaust heat recovery for steam generation.



IN A PROCESS CHEMICAL PLANT, this G-E gas turbine operated continuously for 13,178 hours, or 18 months, before maintenance of process equipment dictated shutdown. It now has a total of 56,000 hours' operation.

Reliability—the vital product feature on the pipeline and in the process plant—is assured from the performance record achieved by the 200 General Electric gas turbines now in service. Evaluate these facts against your requirements:

- 132 G-E gas turbines are now serving industrial users—87 units are on pipelines, 27 units are driving process compressors, and 18 units are in industrial power generation service—with nearly 3,000,000 operating hours;
- a study of all General Electric gas turbines in high-use-factor service (50 units) reveals an average of 98% availability and 99.5% reliability, with many having been in service since the early 1950's; and
- ten units are now in service with over 50,000 hours of operation, 35 units with over 40,000 hours, and 64 units with over 30,000 operating hours.

And, these remarkable records have been set under some of the most severe operating conditions—a few of which are shown in these illustrations.

Reliable General Electric gas turbines—available in a wide range of sizes—are the *economical* answer to your process and pipeline power needs.

FOR MORE INFORMATION call your nearest G-E turbine sales engineer—ask him for a detailed evaluation of G-E industrial gas turbines as matched to your requirements. General Electric Company, Schenectady 5, New York.

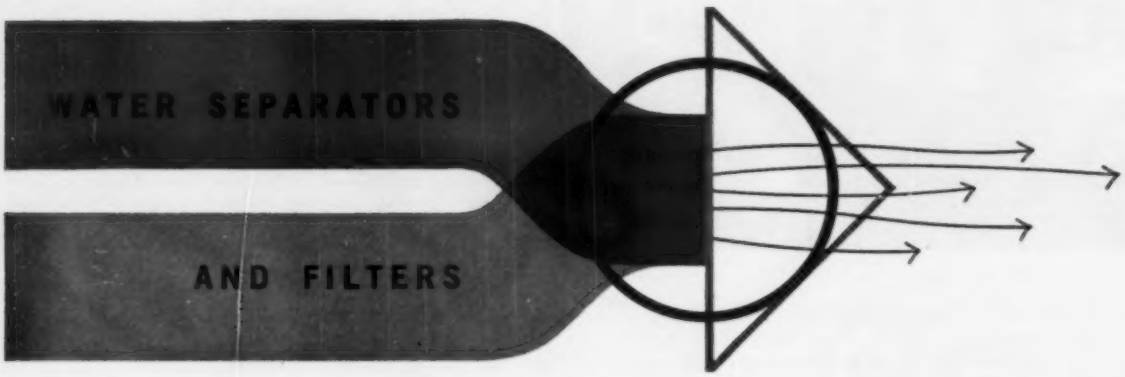
*Equivalent hp

247-42

Progress Is Our Most Important Product

GENERAL ELECTRIC

● Out of many years experience in providing separator and filter equipment for aviation fueling, Warner Lewis Company has developed a 2-stage separator/filter for elimination of jet fuel contaminates. The new Warner Lewis 2-stage separator/filter provides the ultimate protection against fuel contamination in all aviation fuels in current service. This new equipment is installed at the fixed facilities and on refueler trucks or hydrant carts serving most major airports worldwide. It is approved and in production for the Air Force under recent contracts.



WARNER LEWIS Warner Lewis Company Box 3096 • Tulsa, Oklahoma **PROTECTS THE JETS**

DIVISION OF FRAM CORPORATION — In Canada: FRAM Canada Ltd., Stratford, Ontario

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

how to keep metal away from petroleum . . .

UNICOR®

. . and why it pays, in terms of both product and equipment!

Petroleum products and metals are apt to wage war. Life-robbing corrosion attacks the metal, while profit-stealing contamination downgrades the product. But there's an easy way to forestall such trouble. Use UNICOR.

This potent, film-forming, oil-soluble corrosion inhibitor plates out on metal, stands off corrosion by crude or refined petroleum. Only 10 to 20 parts of UNICOR per million of product assures lasting protection against corrosion in pipelines, refinery vessels and tanks.

Purer product, longer equipment life, reduced downtime for maintenance and cleaning, lower power costs . . . all result from using UNICOR. For detailed information and samples write our Products Department.

***See our PSE** ✻

Correct selection and most effective use of petroleum inhibitor and additives involves expert analysis and consideration of many factors. As specialists for over a quarter-century, UOP is able to provide unparalleled field service, brought to you by a member of our staff of *Product Sales Engineers. For detailed information on the UOP family of superior inhibitors and additives call or write our Products Department.

UOP®

UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U.S.A.

WHERE RESEARCH TODAY
MEANS PROGRESS TOMORROW

Need 42-in. Line Pipe?

Bethlehem makes it—electric fusion-weld line pipe from 18 through 42 in. OD, and with walls to ¾ in. in all diameters. Meets all applicable parts of API 5LX specifications. It's made at Steelton, Pa., on a completely modernized mill with capacity of over 35,000 tons a month.

Included among our newly installed facilities are edge and end planers, a U-ing press, an 18,000-ton-capacity hydraulic O-ing press, and batteries of inside- and outside-seam welding machines. The pipe is expanded hydraulically and end-faced.

It's a smooth-flowing, highly automated operation. Production is fast—quality is tops. For more information, call or write the Bethlehem sales office nearest you.

Ever see API high-test line pipe as large as this? It's 42 in. OD, with ½-in. walls. Bethlehem makes it in 40-ft lengths at Steelton, Pa.

How about 62-ft lengths?

Extra-long cars were required to ship this large order of Bethlehem 8⅝ in. ERW line pipe from our Sparrows Point, Md., mill. Lengths reached to 62 ft—that's mighty long pipe!

Bethlehem makes it—electric resistance-weld line pipe from $5\frac{9}{16}$ to 16 in. OD in lengths to 62 ft. Our modern pipe mills at Sparrows Point, Md., are regularly turning out these longer lengths for installation all around the country. Pipeliners like 'em, since they mean fewer welds in the field.

Bethlehem line pipe speeds up line construction in other ways, too. It's good, sound pipe, tested and re-tested at the mill to make sure it will test out OK in the line. Every length is straight as a stretched string, round in the body, and square and accurately beveled on the ends. It's pipe that will line up fast and take a good weld every time.

When you need l-o-n-g lengths of top-quality line pipe, call on Bethlehem. We have a sales office near you.

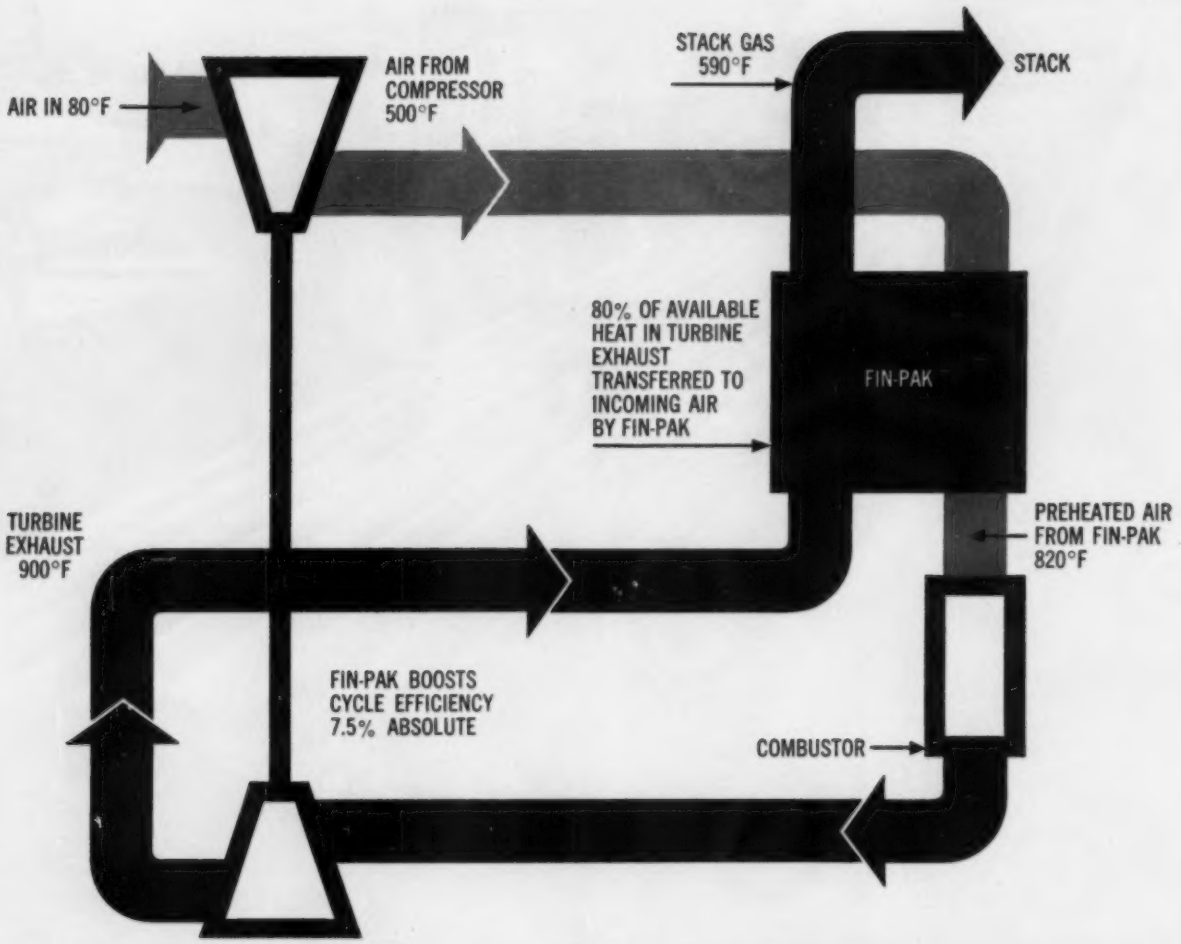
Steel

for Strength
... Economy
... Versatility

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL


AIR IN 80°F
AIR FROM COMPRESSOR 500°F
STACK GAS 590°F
STACK
80% OF AVAILABLE HEAT IN TURBINE EXHAUST TRANSFERRED TO INCOMING AIR BY FIN-PAK
FIN-PAK
TURBINE EXHAUST 900°F
PREHEATED AIR FROM FIN-PAK 820°F
FIN-PAK BOOSTS CYCLE EFFICIENCY 7.5% ABSOLUTE
COMBUSTOR

IF YOU FIND A GAS TURBINE MOST ECONOMICAL FOR PIPELINE COMPRESSORS, YOU SHOULD ALSO CONSIDER A FIN-PAK® BECAUSE:

- *Fin-Pak can cut fuel consumption 30%*
- *Fin-Pak can be installed in less than 500 manhours*
- *Fin-Pak needs little or no maintenance*

If your surveys show that a gas turbine is the most economical power source for pipeline compressor stations, the advantages of a Fin-Pak heat regenerator will make a gas turbine look better than ever. For example:

1. The heat you recover from turbine exhaust with a Fin-Pak can make your turbine run on 30% less fuel*. (The flow diagram at the top of the page shows you how it works.)

2. You can install a Fin-Pak *completely* on a large (5000 to 8000 HP) gas turbine in less than 500 manhours, thanks to Fin-Pak's prefabricated construction, compact size and light weight.

3. Fin-Paks on the pipeline compressor stations have required no cleaning to maintain the performance for which they were designed.

Some Fin-Paks have been in operation for over five years without a maintenance problem. We will be glad to tell you more about the Fin-Pak, and how it can cut your turbine operating costs. Simply call or write The Air Preheater Corporation.

*An 80% effective Fin-Pak in a gas turbine cycle at 6 to 1 pressure ratio and a turbine inlet temperature of 1500°F. can cut fuel consumption by more than 30%.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.
Phone: MUrray Hill 2-8250

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

"320" and "240" open 3 miles per day for Texas gas line

For real trench production there's nothing like a Cleveland. H. B. Zachry's Superintendent Ray Shields reports an average 3 miles of 40" x 54" trench per day with a Cleveland 240 and the Cleveland 320 shown here on an 81-mile section northwest of Fort Worth, for Old Ocean Fuel's 374-mile natural gas line from Graham to the Texas Gulf.

Brand new or even after 10,000 hours service, Cleveland Trenchers dig more trench in more places at less cost. For this kind of production on any size trench check your distributor now on the complete Cleveland line of proved performers.

CLEVELAND TRENCHER

THE CLEVELAND TRENCHER CO., 20100 ST. CLAIR AVE., CLEVELAND 17, OHIO

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

To conquer the peat bogs
of Wisconsin, Houston Contracting
literally took to the air. Recently completed for
the Michigan-Wisconsin Pipe Line Company, this
24-inch, natural-gas pipe line was constructed through some
of the most unstable ground in the United States. Efficient
operation over all types of terrain is typical of Houston's
on-time handling of engineered construction. When you're
thinking of pipe lines, talk to the men at Houston.
HOUSTON
CONTRACTING
COMPANY
R. P. Gregory
H. J. Muckley
E. C. Norris
Geo. A. Peterkin
2807 BUFFALO SPEEDWAY
HOUSTON 6, TEXAS
OIL • GAS • PRODUCTS
WATER PIPELINES

CENTRIFUGAL COMPRESSORS

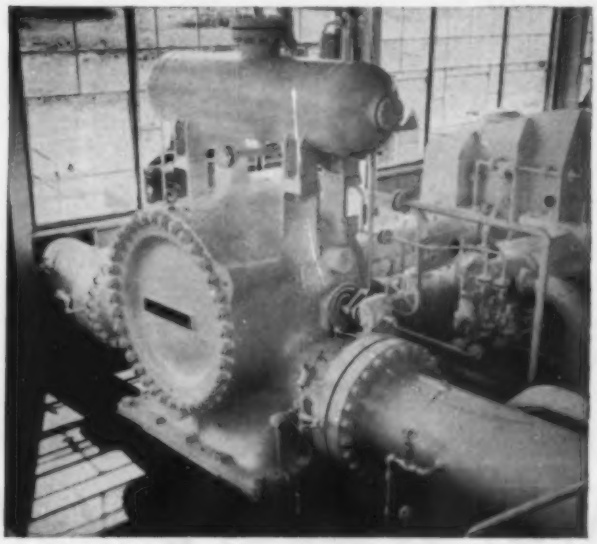
DE LAVAL welded impeller

permits higher horsepower, higher tip speeds, greater design flexibility

Now, with a single welded wheel, compressors rated up to 20,000 horsepower at 6500 rpm are giving excellent service.

Produced by a special welding process developed by De Laval, this new welded wheel construction permits higher tip speeds and fewer stages for a given pressure ratio.

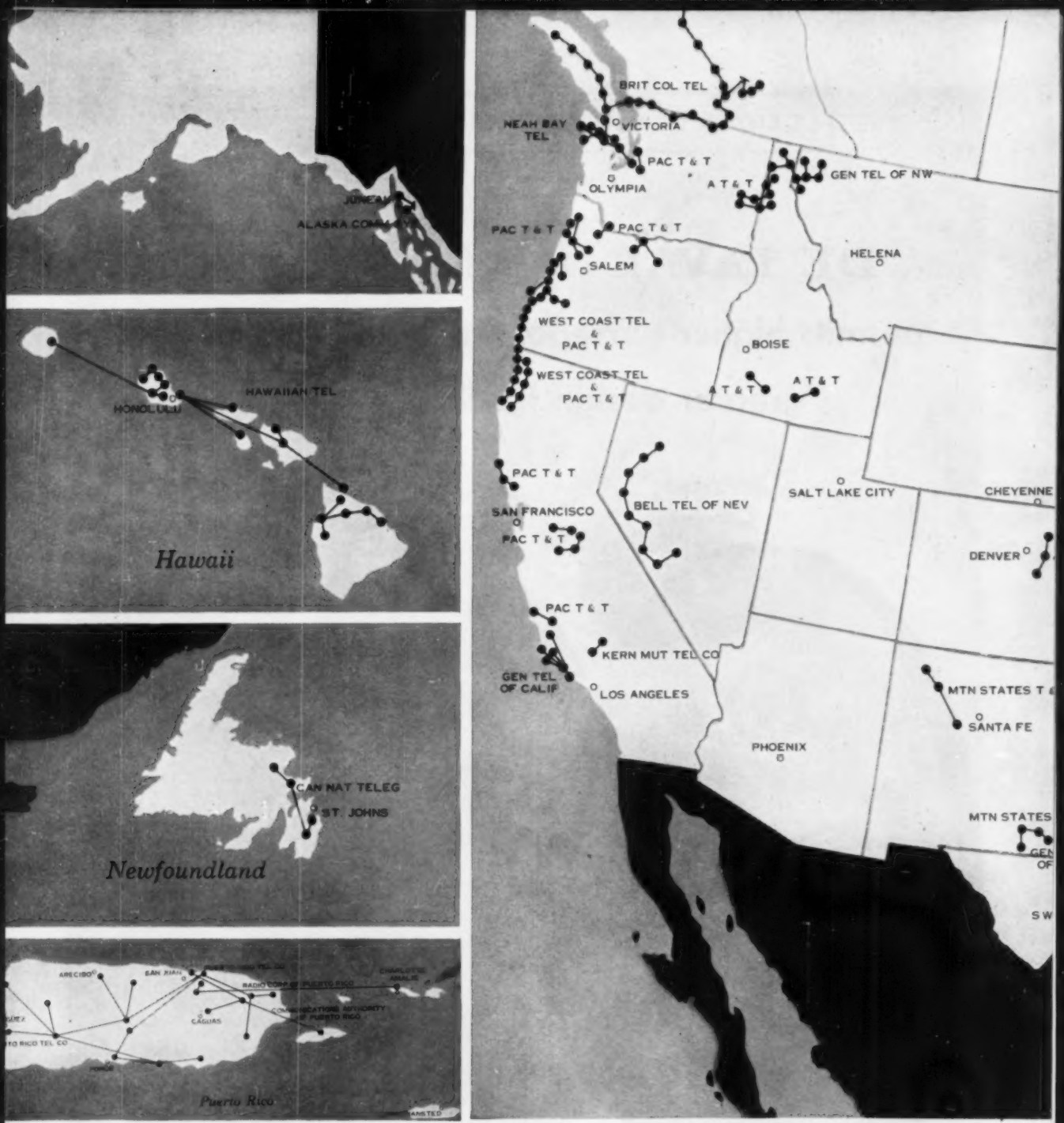
Write for more information on this new welded impeller or contact your local De Laval representative.



Rated at 20,000 horsepower, this compressor, on stream for a prominent pipeline company, is capable of developing a pressure ratio of 1.56 in a single impeller, pumping 800 MMSCFD at an inlet pressure of 652 psia and an outlet pressure of 1020 psia.

DE LAVAL STEAM TURBINE COMPANY
869 NOTTINGHAM WAY, TRENTON 2, N. J.

DL-480 B



Why so many *Lenkurt* microwave systems

First, Lenkurt's Microtel microwave system offers *as standard equipment* many features that are considered "extras" for other systems. For example, Microtel has *automatic* frequency control that assures you maximum frequency stability.

Second, Microtel's superior, constant-output klystron (warranted to 5,000 hours) requires no temperature-compensating oven. Since the tube operates at lower

are springing up across the country

temperatures, life expectancy is greatly increased. Field experience with Lenkurt Microtel indicates that klystron life will average at least 15,000 to 18,000 hours.

Before you spend one penny for carrier or microwave, let our staff engineers help you in system planning. These men are specialists in helping you make fullest and most profitable use of existing facilities . . . and you are assured of equipment recommendations tailored to your needs.

For full details on Lenkurt microwave or for help in system planning, call your nearest Automatic Electric representative, or the Director, Petroleum Industry Sales, Automatic Electric Sales Corporation, Northlake, Illinois.

AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

GENERAL TELEPHONE SYSTEM

There's an Insley Pipeliner working near you

● When it comes to trenching, you'll see plenty of Insleys on the job. That's because Insley Pipeliners make good operators even better—more productive, more profitable.

Design features are the reasons why. Take digging dogs and independent travel, standard on all current models. With digging dogs, the operator can "lock on" hillsides, eliminating constant braking and excessive brake wear. At his option, he can mechanically prevent either forward or backward travel. Independent travel is a big help too. The operator can travel and swing simultaneously, eliminating otherwise wasted time.

These are just a few of the reasons why so many Insley Pipeliners are working near you. And there's an Insley distributor working near you too . . . with complete service facilities and 24-hour parts availability . . . with complete information on the Insley line, up to 1½ cu. yds. bucket capacity, up to 45 tons crane capacity. See him today and get the facts on the profitable Insley Pipeliners.

Digging Dogs • Independent Travel
Many other profitable features

THERE'S AN **INSLEY** WORKING NEAR YOU

INSLEY MANUFACTURING CORPORATION
GENERAL OFFICE—Indianapolis 6, Indiana
Western Regional Office—Alhambra, Calif.

Teletype Model 28 punched tape units

The Teletype Model 28 tape reader and typing tape punch combine proved dependability of operation with a variety of features which help streamline data communications systems and save the time of attendant personnel.

• *Convenience.* On the Model 28 tape reader, a single 3-position start-stop lever controls "on," "off," and "freewheeling." A specially designed tape lid, conveniently hinged, will accommodate either chadless tape or fully perforated tape, without intermediate adjustment.

The Model 28 tape punch not only perforates intelligence into tape—it simultaneously "prints out" the data right on the tape, thus greatly facilitating handling and storage.

• *Low Maintenance.* Both units are designed for extremely low maintenance, with all-metal clutches that require oiling only once or twice a year, depending on usage.

• *Reliability.* Teletype tape equipment is the product of extensive research and precision manufacturing facilities. It is made for continuous, day-in, day-out service with minimum upkeep. Teletype Corporation manufactures this equipment for the Bell System and others who require the utmost reliability from their data communications systems.

Typing Tape Punch

Tape Reader

Send-Receive Page Printer

Automatic Send-Receive Set

FREE Model 28 line folder. Write Dept. 92-L 5555 Touhy Avenue, Skokie, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.

Global aspect steps up pipeline

FRANK H. LOVE, *Editor*

Construction reports to PIPELINE ENGINEER for 12-month period show:

- ☐ **31,376 miles completed or still underway**
- ☐ **34,730 miles planned or proposed**

PIPELINE ENGINEER'S annual construction report, based on data supplied by operating companies and the controlling agencies in countries where the petroleum industry is nationalized, reveals some interesting and unexpected facts. The report, covering the previous 12 months ending October 1, shows pipelines either completed during that period or still under construction total more than a year ago. The figures are: 31,376 miles this year as compared with 22,415 miles a year ago.

A considerable factor in this increase is the accelerated activity in countries outside the United States. In fact, the U. S. was edged out by a slight margin in total mileage, as following figures reveal, and it appears that the margin may be even greater during the next 12 months. In this latter respect, however, a considerable part of construction outside the U. S. will be in Canada and closely linked with that of this country by reason of exports.

Gas transmission systems led the field again this past year in the United States and internationally. Crude oil building was extremely small in the U. S., but due to overseas construction, the overall picture was good. Construction of products pipelines was again second to gas in this country.

In presenting the following tabulations we have separated Canadian figures from other "outside the U. S." construction because of the close affiliation of many projects in the two countries.

Pipelines built or under construction:

U. S.	15,353 miles
Canada	908 miles
Foreign	15,115 miles
Total	31,376 miles

These figures are further broken down as follows:

GAS:	
U. S.	11,273 miles
Canada	490 miles
Foreign	6,132 miles
Total	17,895 miles
PRODUCTS:	
U. S.	3,354 miles
Canada	None
Foreign	2,319 miles
Total	5,673 miles
CRUDE:	
U. S.	726 miles
Canada	418 miles
Foreign	6,664 miles
Total	7,808 miles

A year ago our figures for pipelines built or under construction were these:

Gas	16,492 miles
Products	2,781 miles
Crude	3,152 miles
Total	22,415 miles

Last year we reported a total of 34,756 miles of pipelines planned or proposed, of which 17,121 miles were gas lines, 7034 miles products lines, and 10,601 miles crude oil lines.

Planned or proposed pipelines as of October 1, 1960, are:

U. S.	11,297 miles
Canada	8,167 miles
Foreign	15,266 miles
Total	34,730 miles

And this is the breakdown:

GAS:	
U. S.	6,371 miles
Canada	2,242 miles
Foreign	9,527 miles
Total	18,140 miles
PRODUCTS:	
U. S.	2,940 miles
Canada	2,734 miles
Foreign	1,110 miles
Total	6,784 miles
CRUDE:	
U. S.	1,986 miles
Canada	3,191 miles
Foreign	4,629 miles
Total	9,806 miles

It is interesting to note that total proposed mileage of a year ago is almost identical with this year.

The international growth of pipelining also is clearly indicated by the above statistics.

Gas Pipelines

A big project for the coming year is the one involving import of gas from Canada into the United States. All hurdles have been cleared . . . Canada's Energy Commission, the U. S. Federal Power Commission, California Public Utilities Commission, and the Alberta Provincial Government . . . and, although some right-of-way work may be done this fall, actual construction is not expected until after the first day of the year.

Approximately 2000 miles of pipeline will be built at a cost estimated in excess of $400,000,000. Companies who will be involved in the project in one way or another are Pacific Gas Transmission Company, Pacific Gas and Electric, Alberta Gas Trunk Line Company, Alberta Natural Gas Company, Alberta and Southern, Westcoast Transmission, El Paso Natural, Montana Power Company, and Canadian-Montana Pipe Line Company. Total volume of gas imported initially will be 584,500,000 cu ft a day.

An interesting proposal of recent date has been made by Petroleos Mexicanos (Pemex) and Tennessee Gas Transmission Company—to lay a line approximately 1200 miles in length from the Texas-Mexico border at Reynosa across Mexico to Mexicali on the Mexico-California border. From that point gas would be transported through a 280-mile pipeline, also to be constructed, to electric generating plants of Southern California Edison Company in the Los Angeles basin. Gas supply would be from South Texas fields and those of northern Mexico. Tennessee Gas and Pemex have signed an agreement covering construction and operation of the Mexican portion of the system. An agreement also has been signed with the Edison company

pace

whereby up to 455,000,000 cu ft of gas a day will be delivered over a 20-year period beginning in 1962. The project of course is subject to approval by the appropriate governmental agencies.

El Paso Natural and Colorado Interstate are hoping for early approval by FPC of their Rock Springs project, which will mean construction of more than 1000 miles of pipeline to supply the apparently insatiable southern California market with 470,000,000 cu ft of gas a day. The plan is for Colorado Interstate to build a 155-mile, 34-in. line from Rock Springs, Wyoming, to Provo, Utah, where it would connect with a 371-mile, 34-in. line to be constructed by El Paso Natural from that point to the California-Nevada border near Las Vegas. To take the gas Southern California and Southern Counties Gas would build a 92-mile, 34-in. line. Colorado Interstate further would strengthen its existing system by laying another 476 miles of pipeline and installing 83,880 compressor hp at new and present stations.

In addition to its part in this project El Paso Natural Gas Company has construction plans for 737.7 miles of new pipeline in various locations, consisting of loops and new lines.

Transcontinental Gas Pipe Line has announced plans to lay 345 miles of loops in Texas, Louisiana, Mississippi, Alabama, Georgia, South Carolina, and New Jersey, and a 73-mile purchase lateral offshore from Louisiana.

Transwestern Pipeline Company, who this year completed longest U. S. gas line—from Texas to the Arizona-California border—plans to start adding to that system almost immediately. First additions will be 250 miles of gathering lines and three new compressor stations.

Texas Eastern Transmission Company has a program for looping 182 miles of its line with 20, 30, and 36-in. pipe, and laying an 81-mile, 24-in. line from the new Leidy storage field to its Perulack station in Pennsylvania. Approval of FPC is pending. Still more recent, and not yet filed with FPC, are plans for increasing the system's ca-

pacity by another 150,000,000 cu ft a day. Gas supply for this would come primarily from another pipeline supplier in North Louisiana and would necessitate construction of a line to Texas Eastern's main 30-in. line at Kosciusko, Mississippi. Most of the remainder of the capacity would be provided by looping this 30-in. system.

Continuing the expansion program it has had underway this year, and which will extend over into next, Trunkline Gas Company has still other plans for the future. Announced are 171.7 miles of 24 and 30-in. loops, and 57.4 miles of 20 and 26-in. Louisiana gathering lines.

On the international scene, Gaz de France, the French national agency, has been most active during the last 12 months. Some 326 miles of pipeline already has been completed during the period, and the biggest project of all is still in progress . . . branch lines from the Lacq field-to-Paris trunk system, which was completed earlier in the year. The branches consist of 517 miles of 2 through 12-in. and will service numerous cities and towns.

Several proposals have been made for bringing North Africa natural gas into the European continent, one of them by Gaz de France. Two possible routes are being considered. One would cross the Straits of Gibraltar, the other the Mediterranean Sea. Gas would go to Spain and France, and a 36-in. line some 1750 miles in length is being contemplated.

An Italian group, organized under the name Societa Siciliana Metanadotti, is studying the possibility of moving Hassi R'Mel gas to Cape Bon, Tunisia, then across the Sicilian Channel, and into northern Italy. This would involve approximately 1500 miles of pipeline.

Burmah Oil Company (P.T.) Ltd. has committed itself to building a 1000-mile, 10, 16, and 20-in. pipeline from Sui, Pakistan, to Multan, Lyallpur, Lahort, Sargoda, Main-Wali, Kowra, Sang Jani, Wah, Rawalpindi, and Daod Khel. No starting date has been set, however.

Argentina's YPF, having completed within recent months an 1100-mile gas line from the Campo Duran field to Buenos Aires, now proposes a 1000-mile system from the Comodoro Rivadavia field in Patagonia to the Greater Buenos Aires area. Diameter of the line would be 30-in.

Although there is always difficulty in verifying Russian figures, apparently there are some 3763 miles of gas lines in various stages of construction, with proposals announced for 2850 additional miles.

Products Pipelines

Construction of products pipelines promises something of a boom during the coming year. Heaviest construction will be in the United States and Canada. If the plan to bring Alberta liquefied petroleum products to the Chicago area materializes, this project alone will involve 2185 miles of pipeline. Foothills Pipe Lines, Inc., visualizes a 1300-mile, 16-in. trunk system from the Alberta-Saskatchewan border to Calgary, Edmonton, and Chicago. A gathering system in Alberta consisting of 885 miles of 4 through 16-in. would be built by Westalta Products Pipe Line, Ltd., to deliver into the Foothills system.

Another proposal is by Hydrocarbons Pipeline, Ltd., to construct a 503-mile gathering system in Alberta with deliveries to Calgary, Innisfall, Hughenden storage, and to the Interprovincial Pipe Line Company.

Still another gathering system is being proposed for Alberta. Provincial Products Pipe Lines, Ltd., would lay 700 miles of 3 through 16-in. and make deliveries to Edmonton for export through Interprovincial and Trans Mountain Oil Pipe Line to eastern Can-

Proposed or planned pipelines

The following tables list the company, mileage, pipe size, and location of proposed pipeline projects—crude, products, and natural gas—reported to *Pipeline Engineer*. Company addresses are given when known.

crude lines

Name of Company	Miles	Size, in.	Location
Act Oils, Ltd. Toronto, Ontario, Canada	470	—	Fort St. John to tidewater at Bella Coola, British Columbia, Canada
Arab League Pipeline	1250	—	Mediterranean Sea to Persian Gulf
BP Benzin und Petroleum AG (and seven other German companies)	155	22	Karlsruhe, Germany, to Bavarian refineries
The Barnabos Group Rome, Italy	240	—	Venice, Italy, to Munich, Germany, via Innsbruck, Austria
Belle Fourche Pipeline Co. Casper, Wyoming	78	8	Donkey Creek in Crook County, Wyoming, to Miller Creek and Rozet oil fields
Bituminous Oil Pipeline Co. Calgary, Alberta, Canada	250	—	Athabasca oil sands in northeastern Alberta to Edmonton, Alberta, Canada
Continental Pipe Line Co. Ponca City, Oklahoma	21	8	In Louisiana, between Grand Isle and Golden Meadow
Gillette Pipeline, Inc. and A. W. Hartwig, Inc.	102	—	Dead Horse Creek field to Casper, Wyoming
Humble Oil & Refining Co. Houston, Texas	11	12	New Quintana to Refugio, Texas

ada, the U. S. Great Lakes area, British Columbia, and Washington State.

Mid-America Pipeline Company (see special article in this issue), which will not have its LPG system from Texas and New Mexico to Wisconsin and Minnesota in full operation until December 1, already is looking to broader horizons. Now on its agenda is a 405-mile, 10-in. line from Chicago, Illinois, to Superior, Wisconsin.

What will be among the major products systems built during the coming year has been announced by Transcontinental Gas Pipe Line Corporation. Transco has formed a wholly owned subsidiary, Trans-Southern Pipeline Corporation, to transport liquefied petroleum gas from the Gulf Coast to Southeastern States, a service not now provided. The line will originate at Mont Belvieu, Texas, near Houston, and extend 1080 miles to Danville, Virginia. A 215-mile spur will be laid from Atlanta, Georgia, to the Georgia-Florida state line. Maximum pipe diameter will be 12 in., and initial capacity 60,000 bbl a day. A 35-mile spur from Laurel, Mississippi, to Hattiesburg, and a 25-mile spur from Linden to Demopolis, Alabama, will connect existing privately owned storage facilities. The line is expected to be in operation by November 1, 1961.

Argentina's YPF expects to be active in products pipeline construction as well as gas and has outlined plans for a 10-in. line approximately 650 miles long from the Lujan de Cuyo refinery in Mendoza Province to the Buenos Aires area.

Crude Oil Pipelines

During the last 12 months construction of crude oil pipelines in the United States and Canada has been at a low ebb, but unusually active in foreign areas. Proposals indicate there will be a better balance during the next 12 months. The prospective score stands at 1986 miles for the United States, 3191 miles for Canada, and 4629 miles foreign. This compares with 726 miles for the United States, 418 miles for Canada, and 6664 miles foreign either completed in the last year or still under construction.

The Independent Pipe Line Company, Calgary, Canada, apparently is still considering its project, although how near it is to starting is not known. This pipeline from Edmonton to Superior to Montreal would involve more than 2000 miles.

Pending for several years and still with a big question mark on it is the 600-mile, 30-in. line from Edmonton, Canada, to the U. S. boundary near Northgate, Saskatchewan, of Mid-Continent Pipe Lines, Ltd. At this point it would connect with another proposed line, that of International Oil Pipeline Corporation, which would extend to the Chicago area. The latter would consist of 900 miles of 30-in. (See detailed article on Canada in this issue.)

YPF of Argentina is contemplating laying 390 miles of 14-in. from producing fields in the Neuquen Province to Bahia Blanca, and 630 miles of 10-in. from Mendoza to San Lorenzo.

Another pipeline planned for South America has been announced by the Bolivian Government oil agency (YPFB). This line would extend from Camiri to Sica-Sica—407 miles of 12-in.

The Oasis Group will definitely get underway soon with its 30-in. line from the Dahra area of Libya to Es Sider on the Gulf of Sirte. Other interesting overseas pipeline projects are in the making and a separate article elsewhere in this issue provides the details.

On succeeding pages are shown in tabular form "Proposed or Planned" construction, and construction completed during the last year and that started but still underway.

Name of Company	Miles	Size, in.	Location
Independent Pipe Line Co. Calgary, Alberta, Canada	1073	36	Edmonton, Alberta, Canada, to Superior, Wisconsin
	946	34	Superior, Wisconsin, to Montreal, Quebec, Canada
	146	10, 16	Feeder lines from Calgary to Bellshill Lake, Alberta, Canada
International Oil Pipeline Corp. New York City, New York	900	30	Northgate, Saskatchewan, Canada, to Chicago, Illinois, area
International Refineries, Inc. Wrenshall, Minnesota	—	—	Gathering systems in North Dakota's Wiley field, Bottineau County, and Glenburn field, Renville County
Matador Pipe Line Corp. Denver, Colorado	175	—	Cromer, Manitoba, Canada, to Burke, Bottineau, and Renville counties, North Dakota
Mid-Continent Pipe Lines, Ltd. Edmonton, Alberta, Canada	600	30	Edmonton, Alberta, Canada, to U. S. boundary near Northgate, Saskatchewan
Northern Pipe Line Co. New York City, New York	294	16	Regina, Saskatchewan, Canada, to Clearbrook, Minnesota
Northwestern Refining Co. St. Paul, Minnesota	—	—	Gathering system in Rival and Lignite oil fields, Burke County, North Dakota
	—	—	Gathering system in Glenburn field, Renville County, North Dakota
Oasis Group (Ohio Oil, Amerada, Continental) with Esso Sirte, Libyan- American	86	30	Dahra area of Libya to Es Sider on the Gulf of Sirte
Petroleo Brasileiro S.A. (Brazil)	225	—	Rio de Janeiro, to Belo Horizonte
Rangeland Pipe Line Co. Calgary, Alberta, Canada	111	8	Cessford field in southeastern Alberta, Canada, to Calgary
Royal Dutch/Shell Group The Hague, Netherlands	160	20	Tandjung oil field in South Borneo, Indonesia, to the Balikpapan refinery on the coast
Societa Oleodotti Internazionali (ENI and Societe Financiere Italo-Suisse) Rome, Italy	261	20-26	Genoa, Italy, to Aigle, Switzerland
Sudpetrol AG	325	18	Aigle, Switzerland, to Ingelstadt, Bavaria
Syrian Government Damascus, Syria	500	—	Karshuk field to Mediterranean Sea
Yacimientos Petroliferos Fiscales Argentine (YPF) Buenos Aires, Argentina	390	14	Fields in Neuquen Province, to Bahia Blanca
	630	12	Mendoza to San Lorenzo
Yacimientos Petroliferos Fiscales Bolivianos (YPFB) La Paz, Bolivia	407	12	Camiri to Sica-Sica

products lines

Name of Company	Miles	Size, in.	Location
Britamoil Pipe Line Co., Ltd. Toronto, Ontario, Canada	125	6	From Pincher Creek gas field, Alberta, Canada, to Calgary
	60	8	From Homeglen-Rimbey field, Alberta, Canada, to Edmonton
Esso Petroleum Co., Ltd. London, England	75	10	To link Esso's Fawley refinery rear Southampton, England, to a new depot near London airport
	100	—	From near London to storage installation in Birmingham, England
	70	—	Esso's Fawley refinery, to a new plant of Imperial Chemical Industries on the banks of the River Severn
Estrada Ferroviaria Santos a Jundiai Sao Paulo, Brazil	25	6	Cubatao to Rio Grande, Brazil
Foothills Pipe Lines, Ltd. Calgary, Alberta, Canada	1300	16	Trunk line from the Alberta-Saskatchewan border to Chicago, Illinois
Hughenden Pipeline, Ltd. Calgary, Alberta, Canada	125	—	Westerose South wet gas field to underground storage facilities at Hughenden on east side of Alberta, Canada
Hydrocarbons Pipeline, Ltd. Calgary, Alberta, Canada	503	4-12	Gathering system in Alberta, Canada, with deliveries to Calgary, Innisfail, Hughenden storage, and Interprovincial Pipe Line Co.
Mid-America Pipeline Co. Tulsa, Oklahoma	405	10	Between Chicago, Illinois, and Superior, Wisconsin
Provincial Products Pipe Lines, Ltd. Calgary, Alberta, Canada	700	3-16	Gathering system in Alberta, Canada, with deliveries to Edmonton for export through Interprovincial and Trans Mountain Oil Pipe Line Co., to eastern Canada and the U. S. Great Lakes area and to British Columbia and Washington
Societa Arzionaria Raffinazione Oli Minerali, Ltd. (SAROM) Milan, Italy	190	—	Linking the company's Rafenna refinery to Milan, Italy
Trans-Prairie Pipe Lines, Ltd. Edmonton, Alberta, Canada	16	3	To transport aviation gasoline from the Edmonton, Alberta, Canada, refinery area to Nisku airport south of Edmonton
Trans-Southern Pipeline Corp. (Trans-continental Gas Pipe Line Corp.) Houston, Texas	1080	12	Mont Belvieu, Texas, to Danville, Virginia
	275	—	Spurs from Atlanta to the Georgia-Florida state line; Laurel to Hattiesburg, Mississippi, and Linden to Demopolis, Alabama
Westalta Products Pipe Line, Ltd. Calgary, Alberta, Canada	885	4-16	Gathering system in Alberta, Canada, connecting with a Foothills pipeline, with deliveries to Calgary, Edmonton, and Chicago, Illinois
West Shore Pipe Line Co. (Cities Service, Clark, Continental, Ohio Oil, Pate Oil Corp., Pure Oil, Shell, Socony Mobil, Standard of Indiana, and Texaco)	200	16	From the foot of Lake Michigan, to Milwaukee and the Fox River Valley cities of Wisconsin
Yacimientos Petroliferos Fiscales Argentine(YPF) Buenos Aires, Argentina	650	10	Lujan de Cuyo refinery in Mendoza Province, to Buenos Aires area

gas lines

Name of Company	Miles	Size, in.	Location
Alaska Pipe Line Co. Houston, Texas	400	—	Extension of Kenai-Anchorage line to Fairbanks, Alaska
Alberta Gas Trunk Line Co., Ltd. Calgary, Alberta, Canada	386	26, 30, 36	Main line from Berland River, Alberta, Canada, to Crows Nest Pass
	270	—	Receiving and delivery laterals within Alberta, Canada
Alberta Natural Gas Co., Ltd. (Pacific Gas & Electric Co.—San Francisco, California, and Westcoast Transmission Co., Ltd.—Calgary, Alberta, Canada)	108	36	Across southeastern British Columbia, Canada, to the U. S. border near Kingsgate, B. C.
Algonquin Gas Transmission Co. Boston, Massachusetts	30	—	In Massachusetts
Arkansas Louisiana Gas Co. Shreveport, Louisiana	11.5	10	Replacement in Titus County, Texas
	11	6	New line in Franklin County, Texas
Arkansas Western Gas Co. Fayetteville, Arkansas	—	—	Gathering lines in Coal Hill, Altus, and Rock Creek fields of Johnson and Franklin counties, Arkansas
Border Gas Transmission Co. San Antonio, Texas	300-400	—	Gathering system extending through Webb, Zapata, Starr, Jim Hogg, Brooks, Dimmit, Zavala, Maverick, and La Salle counties, Texas
Burmah Oil Co. (P.T.), Ltd. Karachi, Pakistan	1000	10, 16, 20	From Sui, to Multan, Lyallpur, Lahore, Sargoda, Main-Wali, Kowra, Sang Jani, Wah, Rawalpindi, and Daod Khel
Canadian Industrial Gas, Ltd. Calgary, Alberta, Canada	32	8-10	Westlock Viking Sand field, to Morinville
Cartier Gas Corp. Toronto, Ontario, Canada	170	—	Montreal to Quebec City, Quebec, Canada
Cities Service Gas Co. Oklahoma City, Oklahoma	25	6-10, 16	In Rice County, Kansas
Coastal Transmission Corp. Houston, Texas	75	3-10	Laterals
Cold Lake Pipe Line Co., Ltd. (Bonnyville Oil & Refining Corp. Montreal, Quebec, Canada)	225	—	Cold Lake, Alberta, Canada, to Edmonton
Colombian Petroleum Co. Bogota, Colombia	140	10	From the Cicuco field to Barranquilla, Colombia
Colorado Interstate Gas Co. Colorado Springs, Colorado	116.1	20, 26	In Texas, from Bivins to Fourway, with a loop from Fourway to Morton County junction
	242.8	30, 34	From the Morton County, Texas, junction to Devine, Colorado, to Denver
	155	34	Green River, Wyoming, to Provo, Utah
Colorado Oil & Gas Corp. Denver, Colorado	402	—	Gubik field, Alaska, to Fairbanks

Name of Company	Miles	Size, In.	Location
The East Ohio Gas Co. Cleveland, Ohio	32	26	In Ohio from Ravenna to Painesville
El Paso Natural Gas Co. El Paso, Texas	40.3	20, 34	Loops: on the San Juan main line; and from Goldsmith, to Plains, Texas
	371	34	Thistle, Utah, to the California-Nevada border
	118.7	30	New lines on the Permian-San Juan loops
	227.6	30	Coquat to Sonora, Texas
	210.2	16	From the Keystone main line station, to El Paso, Texas
	140.9	3, 8, 20, 30	From the Puckett line tie-in to Goldsmith, Texas; the Goldsmith plant to the Eunice-Plains loop: the 30-in. southern system to the second loop west of the Florida station; Dumas line to Wasson station; El Paso (NW) 26-in. main line to South Tacoma, Washington; and from Pacific Gas Transmission Company's line to Spokane, Washington, and Bend and Klamath Falls, Oregon
Equitable Gas Co. Pittsburgh, Pennsylvania	37.7	16, 20	Loop lines: from Blacksville in Monongalia County, West Virginia, to Pratt compressor station in Greene County, Pennsylvania: also in Greene County, between line H-106 and Blaine farm; and from Blaine farm to Harston compressor station in Washington County, Pennsylvania
Gas Trunk Line of British Columbia, Ltd. Vancouver, British Columbia, Canada	245	30	In British Columbia southward from Fort Nelson, to connect with existing Westcoast line near Chetwynd
Gaz de France Paris, France	1750	36	North Africa into Spain and France via Gibraltar or the Mediterranean
Houston Texas Gas and Oil Corp. St. Petersburg, Florida	196.2	var.	Laterals
Iron Ranges Natural Gas Co. St. Paul, Minnesota	79	—	Along the Mesabi range from Grand Rapids to Hoyt Lakes, Minnesota
	67	—	From Duluth, along the north shore of Lake Superior to Silver Bay, Minnesota
Lovaca Gas Gathering Co. Corpus Christi, Texas	330	6-20	In Texas from the area of Three Rivers to southeast LaVaca County
The Manufacturers Light and Heat Co. Pittsburgh, Pennsylvania	10.5	24	Replacement in Pennsylvania from Robinson Township, Washington County, to Hopewell Township, Beaver County
Michigan Wisconsin Pipe Line Co. Detroit, Michigan	37	6, 8, 12	Loops in Wisconsin
Mississippi River Transmission Corp. St. Louis, Missouri	94	18	From near Flora, Illinois, to St. Louis, Missouri
Mustang Fuel Corp. Oklahoma City, Oklahoma	90	—	Luther to Oakwood, Oklahoma
National Iranian Oil Co. Tehran, Iran	87	—	Sarejeh natural gas fields to Tehran, Iran
Natural Gas Gathering Co., Inc., and Gulf Resources, Inc. Dallas, Texas	61	10-14	In Zapata and Starr counties, Texas
Natural Gas Pipeline Co. of America Chicago, Illinois	47.13	3-10	Gathering systems in Wise and Carson counties, Texas, and Grady County, Oklahoma
Niagara Gas Transmission, Ltd. Toronto, Ontario, Canada	8	12	From the Trans-Canada main line at Cornwall, Ontario, across the international bridge to Massena, New York
Northern Alberta Pipe Lines, Ltd. (Sage Oil Co., Ltd.— Edmonton, Alberta, Canada)	110	10	Lac La Biche field to Edmonton, Alberta, Canada
Pacific Gas and Electric Co. San Francisco, California	298	36	New line from the California-Oregon border to Antioch, California
Pacific Gas Transmission Co. (Pacific Gas & Electric Co.— San Francisco, California)	614	36	Kingsgate, British Columbia, Canada, to California border, near Klamath Falls, Oregon
Pacific Lighting Gas Supply Co. Los Angeles, California	26	10	In the Gaviota, California, area
The Peoples Natural Gas Co. Pittsburgh, Pennsylvania	2.5	12	In the vicinity of Wall Station, Pennsylvania
Petroleos Mexicanos Mexico, D.F., Mexico	1200	34	Linking Reynosa on the Texas border with Mexicali in California Baja
Pioneer Natural Gas Co. Amarillo, Texas	6.5	10, 20	In Texas, in the vicinity of Big Spring and Potter County
Plateau Natural Gas Co. Colorado Springs, Colorado	6	2	In the area of Colorado Springs, Colorado
Rio Grande Valley Gas Co. Brownsville, Texas	7.7	6, 12	In the vicinity west of Edinburg, Texas, and southwest of Weslaco, Texas
Societa Siciliana Metanadetti (an Italian group)	1500	—	Hassi R'Mel to Cape Bon, Tunisia, across Sicilian channel, into northern Italy
Southern California Gas Co. and Southern Counties Gas Co. Los Angeles, California	91	34	In California, from Ivanpah Lake to Newberry
	9.6	34	In the vicinity of Los Angeles, California
Southern Natural Gas Co. Birmingham, Alabama	7.2	10	New line in Mississippi from Hub field to the Dexter line
	17.6	8	Loops in Mississippi from Hub field to end of Sandy Hook line and in Alabama from Cahaba River to existing Calera loop
Southern Union Gas Co., and Southern Union Gathering Co. Dallas, Texas	15.8	2-8	In the area surrounding Kutz Canyon gasoline plant, near Bloomfield, New Mexico
Texas Eastern Transmission Corp. Houston, Texas	81	24	New line from Leidy storage field to Perulack station, Pennsylvania
	182	20, 30, 36	Loops: from Bechtelsville station, Pennsylvania, to station 26 in New Jersey; and from station 26 to station 27 in New Jersey; from Beaumont, Texas, to Kosciusko station, Mississippi, to station 21 in Pennsylvania; and in Pennsylvania from Perulack station to Delaware River and from station 25 to Chester Junction

Name of Company	Miles	Size, in.	Location
Texas Southwestern Gas Corp. Tyler, Texas	100	—	Coleman County to Jack County, Texas
Transcontinental Gas Pipe Line Corp.	73	8-16	Purchase lateral offshore, Louisiana
Houston, Texas	345	16, 30, 36	Loop lines in Texas, Louisiana, Mississippi, Alabama, Georgia, South Carolina, and New Jersey
Transwestern Pipeline Co. Houston, Texas	250	var.	Gathering lines in West Texas and the Anadarko Basin areas of Texas and Oklahoma
Trunkline Gas Co.	57.4	20, 26	Gathering system from Gordy to Cow Island, Louisiana
Houston, Texas	171.7	24-30	Loops: in Illinois from Effingham to Mattoon and Vienna to Marion; Clinton to Paducah, Kentucky; south of Memphis, Tennessee, to Collierville, Kentucky; and Batesville, Louisiana, to south of Memphis; and in Louisiana from east of Monroe to Kilbourne, Mangham to east of Monroe, north of Longville to Pitkin, and Lowry to south of Iowa, Louisiana
USSR	1300	40	Gazli-Sverdlovsk
Moscow, Russia	500	—	Berezova field to Sverdlovsk
	300	—	Minsk to Riga, Latvia
	500	—	Minsk to Leningrad
	250	—	From Ust-Vilyuisk in northeastern Siberia, to Yakutsk and Pokrovsk
Westcoast Transmission Co., Ltd. Vancouver, British Columbia, Canada	688	—	Looping system from Peace River area of British Columbia-Alberta, to the U. S. border
Yacimientos Petroliferos Fiscales Argentine (YPF) Buenos Aires, Argentina	1000	30	From Comodoro Rivadavia in Patagonia to the Greater Buenos Aires area

Lines built or underway

The following tables list details on crude, products, and gas lines built or under construction in the 12-month period ending October 1, 1960, as reported to *Pipeline Engineer*.

crude lines

Name of Company	Miles	Size, in.	Location	Date Completed
Arabian American Oil Co.	17	34-36	Between Qatif Junction and Ras Tanura, Saudi Arabia	UC
Dhahran, Saudi Arabia	73	30	Loop of Safaniya-Ras Tanura line	UC
Ashland Oil & Transportation Co. Ashland, Kentucky	10	6	Zachariah to Campton, Kentucky	UC
Basrah Petroleum Co., Ltd. and Iraq Petroleum Co., Ltd.	20	32	Fao, Iraq, to artificial offshore island in Persian Gulf	1960
Belle Fourche Pipeline Co. Casper, Wyoming	25	8	Donkey Creek in Crook County, Wyoming, to Miller Creek and Rozet oil fields	11/60
Britamoil Pipe Line Co., Ltd. Toronto, Ontario, Canada	40	—	Vicinity of Drumheller, Alberta, Canada	1959
The British Petroleum Co., Ltd. London, England	60	18	Across South Wales, linking BP's Angle Bay, Milford Haven, tanker terminal with the company's Llandarcy refinery near Swansea	1960
The Buckeye Pipe Line Co. New York City, New York	54	12, 16	Toledo, Ohio, to Samaria, Michigan, to Detroit, Michigan	9/60
Cameron Crude Oil Corp. Tulsa, Oklahoma	10	8	Lick Creek, Arkansas, to Service pipeline	12/59
Clear Creek Inc. Wichita, Kansas	40	—	Gathering systems in eastern Kansas	10/60
Esso Standard (Libya)	100	30	To link Libya's Zelten field to the seaboard	UC
Federated Pipe Lines, Ltd.	33	6-8	In the Swan Hills, Alberta, Canada, area	UC
Calgary, Alberta, Canada	41	16	Oliver to Highbridge, Alberta, Canada	UC
Great Northern Pipeline Co. St. Paul, Minnesota	110	6, 10	Lignite and Newburg fields in Burke and Bottineau counties, North Dakota, to Minot	UC
Gulf Refining Co. Houston, Texas	10.66	10	Loop completion between Monahans and Judkins, Texas	11/59
Humble Oil & Refining Co. Houston, Texas	63	8	Saratosa to Pearsall, Texas	7/60
Interstate Oil Pipe Line Co.	10	8	Loop line between Gwinville and Soso, Mississippi	10/59
Shreveport, Louisiana	15	10	Loop line between Liberty and Mallalieu, Mississippi	10/59
	20	8	New line from Soso to the Bryan field in Mississippi	7/60
Iranian Oil Operating Companies	71.4	26-30	Dasht-i-Baloot to Ganaveh, Iran	1960
Tehran, Iran	23	30	Ganaveh, Iran to Kharg Island	1960
Iraq Petroleum Co., Ltd. London, England	315	30, 32	In northern Iraq, from Kirkuk to the Syrian border, and connecting Rumaila and Fao	UC

Name of Company	Miles	Size, in.	Location	Date Completed
Kenai Pipe Line Co. (Standard Oil Co. of Calif., Western Operations, Inc.—San Francisco, Calif.)	20	8	In Alaska from Mikiski Terminal to Swanson River Unit, 9 miles north of Kenai	UC
Marathon Pipe Line Co.	58	8	New line between Mosherville and Samaria, Michigan	2/60
Findlay, Ohio	8	8	Loop line from Grass Creek to Golden Eagle Dome, Wyoming	1/60
Mid-Continent Pipe Line Co.	8	6	In the Maysville, Oklahoma, area	UC
Tulsa, Oklahoma	104	3-6	In Oklahoma from Enid to Ingersoll—in Alfalfa, Grant and Garfield counties	1/60
	4	6	In the Davenport, Oklahoma, area	4/60
	13	6, 8	Replacements in Oklahoma from Cromwell to Okemah and on the Beggs and Bristow gatherings	1959-60
Mid-Saskatchewan Pipe Lines Dept. Coleville, Saskatchewan, Canada	5	3, 4	From Eureka to South Eureka, Saskatchewan, Canada	6/60
Oil India Private Ltd.	720	14, 16	From upper Assam to Noonmati, near Gauhati, to Barauni, Bihar	UC
Ozark Pipe Line System	3.5	22	Loop line in the Oologah Reservoir, Oklahoma	6/60
(operator: Shell Pipe Line Corp. Houston, Tex.)	7	10, 22	Replacements in the Oologah Reservoir, Oklahoma	6-8/60
Pembina Pipe Line Co., Ltd. Calgary, Alberta, Canada	70	3-10	Gathering lines in Pembina oil fields of Alberta, Canada	UC
Producers Pipelines, Ltd.	35.6	3-6	Gathering systems in Parkman and Pinto	1959
Regina, Saskatchewan, Canada	49.75	3-6	Gathering systems in Parkman, Pinto, Viewfield, South Ingoldsby, Arlington Manor, Cantal, Hastings, Alameda, Oxbow, Glen Ewen, and Steelman	7/60
Pure Transportation Co. Chicago, Illinois	4.3	2-4	Gathering lines in Illinois	1959-60
Service Pipe Line Co.	43.35	8	New line from Artesia to Caprock, New Mexico	1959
Tulsa, Oklahoma	2.06	12	Loop in Kansas, from Neodesha to Renn Junction	3/60
The Shamrock Oil and Gas Corp. Amarillo, Texas	25	8	Hansford County, Texas to the Farnsworth area, Ochiltree County	UC
Shell Pipe Line Corp. Houston, Texas	11.9	6, 8	Burrwood, Louisiana to the Delta pipeline	UC
Societe du Pipe-Line Sud-European Paris, France	465	—	Lavera, France to Karlsruhe, Germany	UC
Sohio Pipe Line Co. Cleveland, Ohio	4.2	8	Loop line from Latonia refinery, Latonia, Kentucky to Mid-Valley Pipeline Company junction	7/60
Soviet Bloc Council for Economic Aid (Comecon)	2500	—	Linking "Second Baku" fields with Poland and East Germany, with branches to Czechoslovakia and Hungary	UC
Standard Oil Co. of Calif., Western Operations, Inc. San Francisco, California	—	20	Submarine loading line in the area of Carpinteria, California	1/60
The Texas Pipe Line Co. Houston, Texas	42	6	In East Texas—from New Hope to Nettleton	7/60
Trans-Prairie Pipe Lines, Ltd. Edmonton, Alberta, Canada	115	4-8	From Milligan Creek oil field in British Columbia, Canada to Dawson Creek and Fort St. John	UC
	29	6	Lateral to Boundary Lake field in British Columbia, Canada	UC
U S S R Moscow, Russia	2300	28	Trans-Siberian system from Ufa and the Tuimazy oil fields in the "Second Baku" region west of the Ural Mountains to Omsk, Novosibirsk, and Irkutsk on Lake Baikal	UC

products lines

Name of Company	Miles	Size, in.	Location	Date Completed
Aztec Pipe Line Co. Ponca City, Oklahoma	36	4	Artesia, New Mexico to Walker Air Force Base	8/60
Bay Petroleum Co. Houston, Texas	13	4	From Copano Bay to connect with another products line along the Texas Gulf Coast	12/59
The Buckeye Pipe Line Co. New York City, New York (jointly with Texas Eastern Transmission Corp.—Houston, Tex.)	90	10	In Ohio from Lebanon to Lima	UC
Cenex Pipeline Co. (Farmers Union Central Exchange, St. Paul, Minnesota)	190	8	Glendive, Montana to Minot, North Dakota	10/60
Great Lakes Pipe Line Co. Kansas City, Missouri	60	8	In Iowa, from Grinnell to Waterloo	7/60
Humble Oil & Refining Co.	42	8	New line between King Ranch in Texas to the Corpus Christi area	12/59
Houston, Texas	27	10	Loop between Baytown and Houston, Texas	8/60
Husky Oil Co. Cody, Wyoming	96	6	Cody, Wyoming to Billings, Montana	UC
Inland Corp. Cleveland, Ohio	2	6	From the 8-in. Lima-Dayton line a few miles north of Dayton, Ohio, to a Sohio Pipe Line Co. terminal near Wright-Patterson Air Force Base	UC
Kaneb Pipe Line Co. Houston, Texas	273	6	Phillipsburg, Kansas to Fairmont, Nebraska, and Yankton, South Dakota	12/59
Michigan-Ohio Pipeline Corp. Mt. Pleasant, Michigan	13	4, 6	In Michigan, between Mt. Pleasant and Purtell	2/60
Mid-America Pipe Line Co. Tulsa, Oklahoma	2170	4-10	From West Texas and New Mexico to Pine Bend, Minnesota, and Jonesville, Wisconsin	UC
National Iranian Oil Co. Tehran, Iran	516	8	From Rey, near Tehran, northeast to Sharud and Meshed, Iran	UC
Okan Pipeline Co. Tulsa, Oklahoma	31	4	From Mocane, Oklahoma to Liberal, Kansas, and between Drumright, Oklahoma, junction and Service Pipe Line Company's Drumright station	9/59-5/60

Name of Company	Miles	Size, in.	Location	Date Completed
Petroleos Mexicanos Mexico, D. F., Mexico	488	8–10	Monterrey to Torreon to Chihuahua	UC
Phillips Petroleum Co. Bartlesville, Oklahoma	79	3, 6	New lines: from American Oil Company's Artesia, New Mexico, plant to Phillips' Mex-Tex gasoline line; and from Crane to Benedum, Texas	7–8/60
Pioneer Natural Gas Co. Amarillo, Texas	4.39	4	In the vicinity of Pampa, Texas	4/60
Plantation Pipe Line Co. Atlanta, Georgia	73	8	Replacement in Alabama from Helena to Montgomery	10/60
Sohio Pipe Line Co. Cleveland, Ohio	3	6	From Dayton, Ohio terminal to Wright-Patterson Air Force Base	UC
Syrian Government Damascus, Syria	310	6	To Aleppo, Damascus, and Latakia from a new government refinery at Homs	UC
Texas Eastern Transmission Corp. Houston, Texas	20 8	10, 12 14	New lines in Texas between Baytown and Mt. Belvieu Orland Park to Blue Island, Illinois	8–11/60 1/60
The Texas Pipe Line Co. Houston, Texas	42	6	In East Texas, between New Hope and Nettleton	7/60
U S S R Moscow, Russia	435	28	Omsk to Novosibirsk	UC
Yacimientos Petroliferos Fiscales Argentina(YPF) Buenos Aires, Argentina	570	12	From the Campo Duran field near the Argentina-Bolivia border, to YPF's San Lorenzo refinery	1960
Yellowstone Pipe Line Co. Spokane, Washington	82	6	Helena to Great Falls, Montana	UC

gas lines

Name of Company	Miles	Size, in.	Location	Date Completed
Alaska Pipeline Co. Houston, Texas	82	12	Kenai, Alaska to Anchorage	UC
Alberta Gas Trunk Line Co., Ltd. Calgary, Alberta, Canada	72	24	Torrington, Alberta, Canada to Rimbey gas plant	7/60
Amere Gas Utilities Co. Charleston, West Virginia	16.5	10	Between Carbon, West Virginia, and Wingrove compressor station	11/60
Arkansas Industrial Pipeline Corp. Shreveport, Louisiana	125	18	Perla to Helena, Arkansas	UC
Arkansas Louisiana Gas Co. Shreveport, Louisiana	98.6 8.9 60.4	16 6, 8 2–8	New line from Aetna field to Jones Mill, Arkansas Replacements in Titus and Wood counties, Texas New lines: in Bossier, Claiborne, Union and Webster parishes, Louisiana; Union, Conway, Johnson, and Pope counties, Arkansas; and Titus and Wood counties, Texas	1959 5–8/60 1959–60
Atlantic Seaboard Corp. Charleston, West Virginia	19.8 1 58.7	26 10 20, 26	Loops between Cleveland and Files Creek compressor station and Lost River station and Dranesville, Virginia New line between Dranesville and Transco tap Between Seneca and Terra Alta compressor stations, from Terra Alta station to Terra Alta storage pool, and line WB loop between Lost River station and Dranesville	1959 1959 8–11/60
Attock Oil Co., Ltd. Rawalpindi, Pakistan	32	6	Connecting the Dhulian oil field with Wah Cement Works and Wah Ordnance factory	1959
Ben Bolt Gathering Co. Corpus Christi, Texas	26	8	In Texas from the Assog field area of Jim Wells County to the Agua Dulce field area in Nueces County	6/60
British Columbia Electric Co., Ltd. Vancouver, British Columbia	46.2	20, 30	New lines in British Columbia, Canada, from Sumas to Langley to Surrey to Coquitlam gate to Burrard thermal generating plant in Port Moody	UC
Central Hudson Gas & Electric Corp. Poughkeepsie, New York	15.7	10	Loopline in New York between Sleightsburg (near Kingston) to Highland (near Poughkeepsie)	9/60
Chicago District Pipeline Co. Chicago, Illinois	52.9	30, 36	In Illinois between Minooka and Chicago	7/60
Cities Service Gas Co. Oklahoma City, Oklahoma	37.17 10.5 123	12, 16, 20 12 6, 10, 16, 30	Loops in Kansas: Franklin, Cass, Johnson, Reno, Rice, and Ellsworth counties; and in the area of Fort Scott Replacement from Hutchinson to Lyons, Kansas New lines: in Woodward County, Oklahoma; in Kansas in Waynoka field, from Welda to Ottawa, Sedgwick County to Comanche County, in the vicinity of Alden; Hutchinson to Lyons; and in the vicinity of St. Joseph, Missouri	1959 1959 1959-60
Coastal States Gas Producing Co. Corpus Christi, Texas	68	6, 8	In Texas from Traylor Ranch field in Calhoun County, to Sunray plant in Jackson County and from southeast La Salle County to Pearsall	1959
Cold Lake Pipe Line Co., Ltd. (Bonnyville Oil & Refining Corp. Montreal, Quebec, Canada)	19	—	To serve the joint Royal Canadian Air Force-U. S. Air Force base and missile testing range at Cold Lake, Alberta, Canada	UC
Columbia Gulf Transmission Co. Houston, Texas	41.1 15.8 11.3	24 10, 24 30 4, 6	Loop between Erath and Centerville, Louisiana Loop and Mississippi River crossing in the vicinity of Lake Providence, Louisiana, and supply line from Jeanerette to Ivanhoe Supply lines in Louisiana: in the vicinities of Duson, Gueydon, Cameron, Grand Chenier, Holly Beach, and Youngsville	1/60 UC 1959-60
Commonwealth Natural Gas Corp. Richmond, Virginia	49.5	8, 18	Loop lines in Virginia between Boswell's Tavern and Gumsprings and between Wakefield and Williamsburg, including a crossing of the James River	9/60
Coastal Transmission Corp. Houston, Texas	15.50	3, 6	New Lines in Texas & Louisiana: from Palacios lateral to Palacios extension; South Hutchins field to North Withers; South Hamman to the Kain lateral; and to the 12-in. main line from North Monte Christo, Sharyland, and Opelousas field	1959-60

Name of Company	Miles	Size, in.	Location	Date Completed
The East Ohio Gas Co. Cleveland, Ohio	10	16	Austintown to Warren, Ohio	9/60
Electricite et Gaz d'Algerie	315	20, 24	Hassi R'Mel to the Mediterranean coast, with branches to Oran and Algiers	UC
El Paso Natural Gas Co. El Paso, Texas	121.4	10, 20	From the 26-in. main line in Oregon to Portland and Eugene	UC
	79.2	6, 12, 16, 20	New lines: between the Terrell and Puckett plants; from the El Paso (NW) 26-in. main line to Uintah County, Utah; from the Davis field gasoline plant to the 20-in. Sutton-Goldsmith line; and from Phoenix, Arizona to Ocotillo power plant	1959-60
	125.6	30	Permian-San Juan loops	6/60
Equitable Gas Co. Pittsburgh, Pennsylvania	34.4	16, 20	In West Virginia a cross line replacement between Farmington and the former Downs station in Marion County and loop lines between the Downs' cross line and Blacksville in Monongalia County and between Lumberport measuring station in Harrison County and the former Downs station; and a loop line in Pennsylvania between Pratt station in Greene County and line H-106	10/59-10/60
Fort Smith Gas Corp. Fort Smith, Arkansas	2.44	1, 2, 4	Various new line and replacement	8/60
Gas Trunk Line of British Columbia Ltd. Vancouver, British Columbia, Canada	55	—	Extension to Nig Creek, Laprise, and East Laprise fields of British Columbia, Canada	UC
	30	—	Extension to B. C.-Alberta boundary, serving Boundary Lake field	UC
Gaz de France Paris, France	19.27	3, 12, 16	Branch lines from St. Hilaire des Loges to Fontenay le Comte and from Ferolles-Attilly to Alfortville	11/59
	213.76	20	Gaz de Lacq trunk line from Ruossines to Epinay-s/Seine	3/60
	517.65	2, 12	Gaz de Lacq branch lines from: Castillon to Bergerac; Menespiet to Perigueux; Brizambourg to La Rochelle; Chaunay to Parthenay; L'Oie to Les Sables D' Olonne; Pont St. Martin to Paimboeuf; Exideuil to Limoges; St. Loup to Nevers; Dijon to Montbard; Brignais to Vallee de L'Ondaine; St. Pere-s/Loire to Orleans and Briare; and Bordeaux to Arcachon	1960
	93.21	4, 8	Ardennes feeder from Florange to Montherme	6/60
Hope Natural Gas Co. Clarksburg, West Virginia	21	20	Replacements in West Virginia between Ellenboro and Schultz and between the Kennedy and Sweeney stations	7-9/60
Houston Pipe Line Co. Houston, Texas	133	4, 6, 12, 18, 30	In 10 to 20 locations in an area along the Gulf Coast between McMullen and Jefferson counties, Texas	1959-60
Houston Texas Gas and Oil Corp. St. Petersburg, Florida	36	4	From the 24-in. main line to Michigan Chemical	UC
Kansas-Colorado Utilities, Inc. Colorado Springs, Colorado	0.5	4	Replacement in the vicinity of Springfield, Colorado	UC
Kansas-Nebraska Natural Gas Co., Inc. Hastings, Nebraska	19.8	8,20,26,30	Enlargement of gathering facilities in Kansas Hugoton field	8/60
	12.5	8	Enlargement of line from Northport to Alliance, Nebraska	UC
	63	4-8	Miscellaneous gathering lines in Colorado	1959-60
	7	4	Miscellaneous gathering lines in Kansas and Oklahoma	1959-60
	179.5	2-6	New lines: in the vicinity of Quinter, Collyer, Zurich, Grinnell, Grainfield, and Park, Kansas; and in Nebraska from Kimball north to Banner gas plant and from Alliance to Chadron, with laterals to Crawford, Hay Springs, Rushville, Gordon, and Hemingford	UC
The Kansas Power and Light Co. Topeka, Kansas	5	6	Gathering lines in the McKenney field and Barber County, Kansas	7/60
	4	12, 16, 18	Replacements in Reno County, Kansas	UC
Lone Star Gas Co. Dallas, Texas	136.55	6-12, 20, 24	New lines in Stephens, Tarrant, Rusk, Erath, Eastland, Ellis, Parker, Dallas, Palo Pinto, Grayson, and Runnels counties, Texas; and in Oklahoma in Stephens County and near Broken Bow	1959-60
Louisiana Intrastate Gas Corp. Lafayette, Louisiana	9	12	Replacement in Louisiana from Tullos to Joyce	UC
	14	8	New line from Prairie Roane to Port Barre, Louisiana	6/60
The Manufacturers Light and Heat Co. Pittsburgh, Pennsylvania	70	20	In Pennsylvania from Sideling Hill Mountain to Abbottstown	8/60
	58.1	4, 6, 8, 12, 16, 20	In Pennsylvania from Point Marion to Addison and in Somerset and Fayette counties; and in Victory storage field, Marshall County, West Virginia	UC
Michigan Consolidated Gas Co. Detroit, Michigan	47.3	30	Loop line between Ovid and Six Lakes, Michigan	UC
Michigan Wisconsin Pipe Line Co. Detroit, Michigan	533	24, 30	Loops in Kansas, Iowa, Illinois, Indiana, and Michigan	UC
	178	16, 20, 30	New lines in Wisconsin: from Appleton to Marshfield; and Weyauwega to Marinette	UC
	231	4-8	Miscellaneous laterals in Wisconsin, Missouri, and Iowa	UC
Midwestern Gas Transmission Co. Houston, Texas	504	24	Main line from the International boundary near Noyes, Minnesota to near Marshfield, Wisconsin	UC
	54	3-8	Laterals	
Montana-Dakota Utilities Co. Minneapolis, Minnesota	13	10, 12	Loop line in North Dakota from Mandan to 13 miles west	7/60
	16	12	Loop line in Montana between Bridger and Joliet	UC
	23	16	Replacement of the Cabin Creek, Montana-Golva, North Dakota, 12-in. line	7/60
Mountain Fuel Supply Co. Rock Springs, Wyoming	24.4	20	Loop line between Yellow Creek, Wyoming, and Coalville, Utah	10/59
	20.2	20	Loop line in Wyoming from Piedmont to Yellow Creek	UC
	25.6	18, 20, 24	Replacements from Mt. Dell Reservoir to Salt Lake City, Utah, and in Wyoming between Kanda Junction and Black's Fork River	UC
Mustang Fuel Corp. Oklahoma City, Oklahoma	11	8	Loop line from Newcastle to Cole, Oklahoma	5/60
	155	12	From Moore to Muskogee, Oklahoma	UC
	56	8	New lines in Oklahoma between Criner and Elmore and between Navina and Lovell	4-7/60
Natural Gas Pipeline Co. of America Chicago, Illinois	187.7	24	From Kiowa County, Oklahoma to Woodward County, Oklahoma, to Ford County, Kansas	UC
	153.1	36	Through Ford, Lincoln, Mitchell, and Cloud counties, Kansas; and Mills, Montgomery, Mahaska, Keokuk and Washington counties, Iowa; with 30-in. crossing of Missouri River between Cass County, Nebraska, and Mills County, Iowa; and 24-in. crossing of Big Blue River, Gage County, Nebraska	UC

Name of Company	Miles	Size, in.	Location	Date Completed
Natural Gas Storage Co. of Illinois	—	36	Crossing of Illinois River	9/60
Chicago, Illinois	0.9	10, 12, 20, 24	Galesville and Mt. Simon gathering	10/60
Northern Natural Gas Co.	530	2-16	Branch lines in Iowa, Minnesota, and Wisconsin	UC
Omaha, Nebraska	113	24-30	Loops in Oklahoma, Kansas, Nebraska, and Iowa	UC
The Ohio Fuel Gas Co.	7	3-6	New lines in Ohio: near Leo in Vinton County; near Creola in Vinton County; and near Zanesville	5-8/60
Columbus, Ohio	22	4-20	Replacements in Ohio: in Mt. Vernon, Medina County; near Junction City, Perry County; from Cedarville to Columbus; Ravenswood to Sugar Grove; in Pickaway County near Jackson Township; near Rix Mills, Muskingum County; and in Madison and Pickaway counties	6-9/60
Oklahoma Natural Gas Co.	20	12	Gathering facilities from the West Edmond field to the Okarche, Oklahoma, area	UC
Tulsa, Oklahoma				
Old Ocean Fuel Co.	366.1	16, 20, 24	From Old Ocean field in Brazoria County, Texas to Handley, Eagle Mountain Lake, and Graham	9/60
(Texas Electric Service Co. Ft Worth, Tex.)				
Pacific Gas and Electric Co.	10	20	New line from Pittsburg to Walnut Creek, California	7/60
San Francisco, California	22.66	12, 16	Loops in California from: Berenda to Chowchilla; Old Adobe to Novato; Novato to Hamilton field; and in the Fresno area	7/60
Pacific Lighting Gas Supply Co.	116	34	From Needles to Newberry, California	7/60
Los Angeles, California	12	6	In the California areas of Shafter and McKittrick	4-10/60
Pakistan Industrial Development Corp.	27	8	Linking Haripur gas field in Sylhet to the fertilizer and power plant at Fenchuganj	1960
Pakistan Petroleum, Ltd.	2	6	Gathering line in Sylhet, East Pakistan	UC
Karachi, Pakistan	11	4	New line in the vicinity of Chhatak	3/60
Pan American Gas Co.	6	8	From the Sweeny field in Brazoria County, Texas to Phillips Petroleum Company's refinery at Old Ocean, Texas	9/60
Tulsa, Oklahoma				
Peoples Gulf Coast Natural Gas Pipeline Co.	371.2	30	Loops in Wharton, Fort Bend, Harris, Polk, Angelina, Nacogdoches, and Cass counties, Texas; Miller, Hempstead, Pulaski, Lonoke, White, Independence, and Jackson counties, Arkansas; Stoddard, Bollinger, and Cape Girardeau counties, Missouri; and Shelby, Moultrie, and Piatt counties, Illinois	UC
Chicago, Illinois	58.80	6-10	Laterals in Brazoria, Galveston, Aransas, and Refugio counties, Texas, with a crossing of the Brazos River	UC
The Peoples Natural Gas Co.	34.75	12, 20	In Pennsylvania: in the vicinity south of Girty station; in the vicinity of Mars; Valley station to Girty station; Imperial to Aliquippa; Mt. Royal to King farm; Jeannette to Greensburg; and from the Kiski River to Center Valley	7-9/60
Pittsburgh, Pennsylvania				
Petroleos Mexicanos	1138	12, 14, 16, 24	From Ciudad Pemex (Tabasco) to Mexico City to Salamanca; from Monterrey, to Torreon, to Chihuahua	UC
Mexico, D.F., Mexico				
Phillips Petroleum Co.	159	2-16	Gathering lines in Lea, Eddy, and North Eddy counties, New Mexico	12/59
Bartlesville, Oklahoma	20	6-12	Gathering lines in Ector County, Texas	1959
	17	3-16	Gathering lines in central Oklahoma	UC
Pioneer Natural Gas Co.	31.94	10, 20	Enlargement in Texas, from Lubbock, to Lorenzo and Plainview, to Tulia	3/60
Amarillo, Texas	41.19	3-8, 12, 15	New lines in Texas between Hereford and East, Earth and West, Tom Green County and the Permian Basin pipeline. Hansford and Ochiltree counties, and in Potter, Gray, and Ector counties	1959-60
Plateau Natural Gas Co.	11.50	2	New line in the vicinity of Holly, Colorado	11/59
Colorado Springs, Colorado	3	4, 6	Loops in the vicinity of Goodland, Kansas	11/59
Rio Grande Valley Gas Co.	4.4	4, 6	Texas gathering lines in the vicinity of San Juan, and north of Mercedes	1959-60
Brownsville, Texas	10.6	2, 6, 8	New lines south of La Feria and north of Mercedes, Texas	3-8/60
Rocky Mountain Natural Gas Co. Inc.	65	8	Colbran, Colorado, south to Montrose	UC
Denver, Colorado	30	—	Gathering lines in the Colbran, Colorado, area	UC
Saskatchewan Power Corp.	66	4, 8	New lines in Saskatchewan, Canada: Yorkton to Canora to Kamsack; and Aylsham to Carrot River	8/60
Regina, Saskatchewan, Canada	150.6	4, 6	New lines in Saskatchewan, Canada: Tisdale to Nipawin; Parkbeg to Assiniboia; and Belle Plaine to Ormiston and Claybank	UC
The Shamrock Oil and Gas Corp.	113	4-8, 12, 16, 20	In Texas, from Shamrock's refinery in Moore County to Amarillo and from Ochiltree County to northwest Hutchinson County	4-5/60
Amarillo, Texas				
South Carolina Natural Gas Co.	34.8	4-8	Steedman to Batesburg to Ridge Springs to Edgefield, South Carolina	7/60
Columbia, South Carolina				
South Texas Natural Gas Gathering Co.	270	4-20	From the McAllen, Texas, area to southeast La Salle County	3/60
Corpus Christi, Texas	28	10, 12	In Texas, from May field, Kleberg County to LaGloria field, Jim Wells County	UC
Southern California Gas Co. and Southern Counties Gas Co.	117	36	Newberry to Placentia, California	8/60
Los Angeles, California	3.4	34	In the vicinity of Los Angeles, California	12/59
Southern Counties Gas Co.	14.4	24	Loop from Moreno to Perris, California	1959
Los Angeles, California				
Southern Natural Gas Co.	32.7	16, 20, 24	Loops in Louisiana: from Gate 6 to Toca; Gloria to Toca; and end of the 24-in. Toca-to-Seaway loop to the 24-in. Seaway-to-Hwy 90 loop	1959-60
Birmingham, Alabama	19.3	24	Loop in Mississippi from Gate 7 to Gate 9	1959
	69.1	20-24	Loops in Alabama: from Gallion to Gate 19A, and Elmore to Notasulga Gate	1959
	123.9	14-20	Loops in Georgia: from Ocmulgee to Wrens; Hwy 7 Gate to Ocmulgee; and Griffin Gate to South Atlanta	11-12/59
	130.8	4, 6, 10, 12, 16, 18	New lines. In Louisiana: from Montegut field to Gloria; South Lake Long field to Montegut; Coffee Bay field to Lake Enfermer line; and Saturday Island field to Manila Village line. In Alabama: from end of 8-in. Calera loop to end of Calera line. In Mississippi: from Cranfield to Gwinville	1959-60

Name of Company	Miles	Size, in.	Location	Date Completed
Southern Union Gas Co. and Southern Union Gathering Co. Dallas, Texas	1	8	Loop line from the Clovis, New Mexico, compressor station to one mile north	1959
	30.4	4-14	New lines in New Mexico: from the Pan American gasoline plant near Artesia to Red Lake compressor station near Artesia; and in the area surrounding Kutz Canyon gasoline plant near Bloomfield	UC
Suburban Gas Gathering Co. Corpus Christi, Texas	13	4-8	In Texas, from Port Acres to Port Arthur	1/60
Tennessee Gas Pipeline Co. Houston, Texas	25	30	Loop line eastward from Hamburg, New York	UC
Texaco, Inc. Houston, Texas	11	20	Paradis, Louisiana to the Mississippi River	9/60
Texas Eastern Transmission Corp. Houston, Texas	17	30	Loops between Station 27 in New Jersey and Staten Island, New York, and Bechtelsville Station, Pennsylvania	12/59
Texas Gas Transmission Corp. Owensboro, Kentucky	92	30	Loop line from Bastrop to Eunice, Louisiana	1959
	135.86	30	Loop line from Sharon, Louisiana to Middletown, Ohio (in Louisiana, Arkansas, Mississippi, Tennessee, and Kentucky)	1959
	108.59	12, 26	Loop lines: from Slaughters, Kentucky, to Middletown, Ohio (in Kentucky, Indiana, and Ohio, with a crossing of Green River near Slaughters); and in Kentucky from Dixie field to Robards Junction	1959-60
	24.25	30	Loop lines in Louisiana near Monroe, Alexandria, and Eunice	UC
	96.46	10, 12	New lines in Louisiana: from Roanoke to Grand Chenier; Baldwin to Little Bayou Pigeon field; Grand Chenier to Blk 33 offshore; Grand Chenier to Blk 9 offshore; Thibodaux to Chevreuil field; and Franklin to Bayou sale field	1959-60
Trans-Canada Pipe Lines, Ltd. Toronto, Ontario, Canada	51	30	Extension from Winnipeg to Emerson, Manitoba	8/60
Transcontinental Gas Pipe Line Corp. Houston, Texas	100	20, 30, 36	Loops in New Jersey, Pennsylvania, Texas, and Louisiana	1959
	1	16	Crossing of the Delaware River in New Jersey	UC
	53	8, 10, 20	Purchase laterals in Texas, and offshore Louisiana	1959-60
Transok Pipe Line Co. Tulsa, Oklahoma	43	24	Jenks to Oologah, Oklahoma	UC
Transwestern Pipeline Co. Houston, Texas	645	30	Roswell, New Mexico to the Arizona-California border	7/60
	288	24	Northeast lateral originating at Canadian, Texas, in the Panhandle field	7/60
	224	20, 24	Southeast lateral to Puckett field, Pecos County, Texas	7/60
	856	4-16	Laterals and gathering lines	7/60
Trunkline Gas Co. Houston, Texas	204.9	26	New lines from Rossville, Illinois to Elkhart, Indiana, and Tuscola, Illinois, to Rossville	2-3/60
	507.6	24, 30	Loop lines: from Marion to Effingham, Illinois; in Tennessee from Collierville to Brownsville to Union City; Union City to Clinton, Kentucky; Kilbourne, Louisiana to Batesville, Mississippi; in Louisiana from Pitkin to Pollock to Mangham; and in Texas from the Trinity River to the Neches River, and Liberty County to Hardin County	1959/60
	181.3	4, 6, 12, 14, 16, 20	Gathering systems: in Louisiana from Lowry to Cow Island, and south, with tie-ins going east of Esther, and south of Gueydan; in Louisiana from south of Lower Mud Lake, to Blk 67, West Cameron area, and south of Cow Island to near Fresh Water Canal to Blk 26, Vermilion area, with tie-in going to Blk 14, Vermilion area; also in Louisiana from Blk 14 to Blk 27, Vermilion area; and in Texas from Katy to Hitchcock	1959-60
U S S R Moscow, Russia	1120	40	Gazli to Chelyabinsk	UC
	200	—	Samarkand to Tashkent	UC
	405	—	Saratov to Gorki	UC
	800	32	Stevropol to Moscow	UC
	800	40	Krasnodar fields to Serpuklov	UC
	438	—	Dashava to Minsk	UC
United Fuel Gas Co. Charleston, West Virginia	18.5	26	Loop line westward from Panther Mountain near Clendenin, West Virginia	9/59
	4.7	16	New line from the Kenova station to the Ceredo station	11/59
United Gas Pipe Line Co. Shreveport, Louisiana	8.6	30	From the McGee Bend 30-in. loop to Angelina and San Augustine counties, Texas	UC
	63.4	8, 30	Loop lines from the Sealy-Katy loop to Austin and Waller counties, Texas; and in Louisiana from Lirette to the Mississippi River crossing in the vicinity of Luling	5-6/60
	32.22	8, 16, 20	New lines to Plaquemines Parish, Louisiana, from Cyprien Bay and Bastian Bay fields and East Bastian Bay	2-6/60
	17.99	16	To Terrebonne Parish, Louisiana, from Lapeyrouse field and Four Isle Dome	1959-60
	20.15	16, 20	Willow Glen power plant to Iberville Parish, Louisiana, and Belle Isle field to St. Mary Parish	4-6/60
	2.65	10	Hornbuckle, et al fields to Jackson County, Texas	4/60
United Natural Gas Co. Oil City, Pennsylvania	17.28	6, 8	New line between Mercer and Clarksville, Pennsylvania, and from Springboro, Pennsylvania, to the Ohio state line	11/59-1/60
West Ohio Gas Co. Lima, Ohio	5.2	6, 8	Replacements in Ohio from Columbus Grove to Ottawa and Delphos to Middle Point	4-7/60
	10	4, 6	New line from Lima to Spencerville, Ohio	8/60
Western Slope Gas Co. Denver, Colorado	61.6	4-8	New line in Mesa County, Colorado, from the 8-in. main line in section 7 to American Gilsonite plant in section 11 and from gathering system T2N, R3W, to a point on the above line; and gathering lines in Rio Blanco and Garfield counties	1959

EQUIPMENT MAINTENANCE
. . . one of a series

Contractor views . . .

EQUIPMENT MAINTENANCE

FRANK H. LOVE, *Editor*

H. C. Price Co. program involves both "on job" and "between job" procedures.

TODAY'S PIPELINE CONTRACTOR to show a profit must keep a sharp watch on every phase of his operations.

Faced with a growing world-wide competition, which has forced contract prices to remain virtually stationary for a decade, and steadily increasing labor and equipment costs, he must plan well, constantly improve his construction techniques, and employ only the most efficient equipment.

A big-inch spread fully equipped for work in rocky country may cost $2,000,000 or more. If the spread is idle for short periods of time it is impossible to reduce the spread operating cost appreciably. Such cost without production is a direct loss to the contractor.

It is essential that the equipment be kept in good working condition to avoid losses that are incurred when the spread is idle.

Each contracting firm has its own procedure for maintaining and repairing equipment, designed to best fit individual requirements. H. C. Price Co., Bartlesville, Oklahoma, has participated in the construction of approximately 25,000 miles of pipeline since it welded a line for The Texas Pipe Line Company back in 1928.

It has a two-direction program: Maintenance while a job is in progress, and a more general overhaul between jobs.

Maintenance on the Job

Each main line spread has assigned to it one chief mechanic and 10 or 11 mechanics. Each gang . . . ditch, dope, pipe, welding, etc. . . . has a mechanic specifically assigned to it, although there is a certain amount of interchange and any mechanic will assist another gang when needed. There is also a mechanic and assistant for keeping motorized equipment in repair. These two men do a large part of the work in a shop or warehouse, but are subject to call out on the line at any time. Then, there usually are two or three utility men who might be called roving mechanics because they work on any and all equipment — hoes, tractors, cranes, etc.

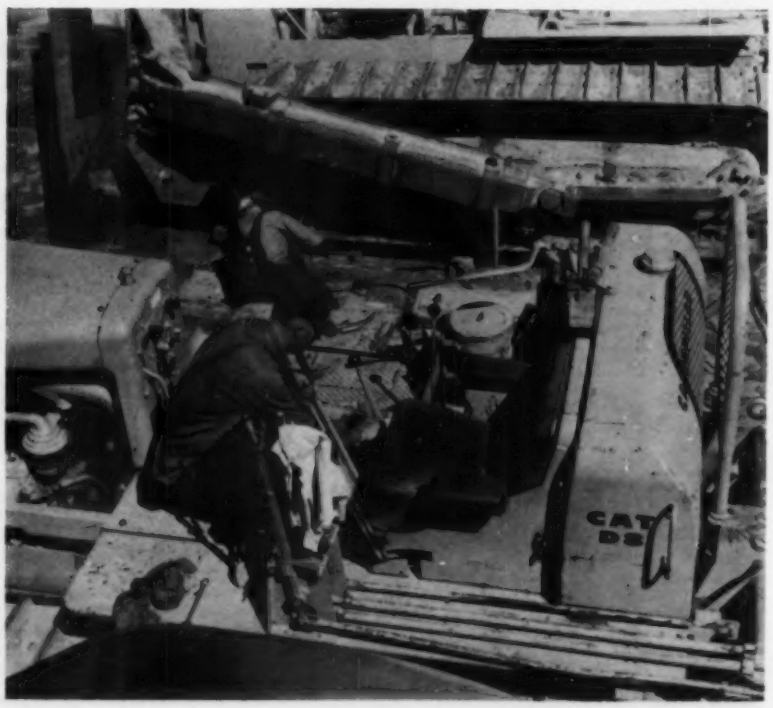
One of the features of the maintenance program is the special parts vans adapted for use by the Price organization. These vans, of which there are three or four in each spread, are stocked with all needed parts. They are specialized to the extent that one van will stock ditching machine parts, for example, another parts for hoes, shovels, cranes, tractors, and another miscellaneous items such as flares, welding rod, etc. A material man is assigned to keep the vans stocked with the proper parts.

The vans have been a big money saver, Price officials say. When they move onto a new job it is not necessary to rent a building, install bins, etc. The vans are ready to go to work when they arrive . . . there is no lost time. And, of course, the high degree of mobility makes on-the-job servicing much faster.

Conditions under which pipelines are constructed necessitate the liberal use of greases and oils. Each spread superintendent determines what oils and greases are used. When possible these are purchased locally; however, there are certain special products that must be bought elsewhere and shipped to the construction location. Certain transmission greases for various types of cars, trucks, tractors, track roller grease, special lubricating greases, and hydraulic oil are among these.

Each spread has a fully equipped truck for greases and oils, and another for fuel, to assure that machines along the right-of-way are adequately serviced. These trucks are constantly on the go throughout the day, patrolling the right-of-way and servicing the spread from one end to the other. Nor does this end their tour of duty. After the gangs have finished the day's work, they again make the rounds and service equipment.

Mechanic bolts up the floor plate after overhauling transmission on a D-8 Cat.



VITAL TO PROFITS

Such diligence would seem to be adequate for all purposes, but mud, water, sand, and dust take a heavy toll, so there are also buckets of grease and oil on each piece of equipment. When the equipment is not in use temporarily, a swamper greases and oils it. Certain parts need to be greased two or three times a day. If there has been no break during the day to permit greasing, the swamper and grease man do a complete job at the end of the day when the spread is shut down.

Maintenance Between Jobs

When a job is completed and before undertaking the next one, a more general overhauling is given.

One method is to rent four or five acres of land close to where the work terminated, or the equipment may be brought into the main warehouse of the spread. Price prefers the acreage

Welder attaches a rock shield over track rollers on a bulldozer.

Each piece of equipment receives a new coat of paint as a final touch after repairs have been made.

On-the-job repairs being made to welding machines.

Checking over a sideboom tractor engine before starting repairs.

Steam cleaning backhoe parts before reassembling, in field overhaul between jobs.

Conditions under which pipelines are constructed necessitate liberal use of greases and oils. A specially equipped truck such as this constantly patrols each spread, providing the required service.

H. C. Price Co. office (foreground) at central warehouse (background) where equipment is overhauled, supplies and surplus equipment stored.

plan because it provides a larger working area.

Equipment is taken down, unit by unit, cleaned, repaired, painted, and the company decal replaced. While the equipment is idle, between jobs, each machine will be started up once a week and run for a short time to keep it operable.

Last fall the company established a central warehouse at La Vergne, Tennessee, just outside Nashville, where equipment is sent that needs major overhauling. Work can be done cheaper here than in the field due to the better facilities that are available, which include air hammers for track work, a press, buffers, sanders, grinding machines, overhead trolleys and hoists, heavy duty steam cleaners, and a paint shop.

Not always is it necessary to tear a unit down completely, and, of course, in such cases only essential repairs are made. As a guide, each item of equipment is accompanied with a report from the field outlining what repairs are needed.

The warehouse also serves purposes other than that of equipment maintenance and repair. Being centrally located insofar as H. C. Price Co. activity is concerned, it is used also as a surplus equipment and purchasing depot.

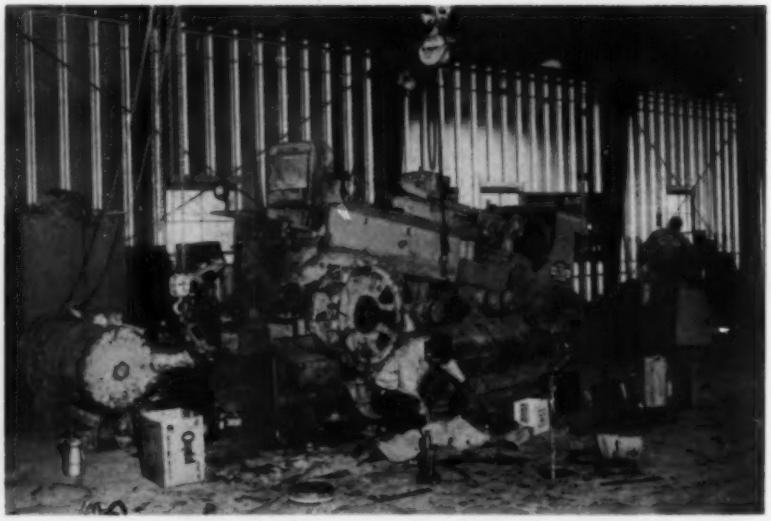
Purchases of trucks, equipment of all kinds, and parts as needed at this location are made through this office after being cleared through the main headquarters in Bartlesville.

In the role of a clearing house, supplies and equipment no longer needed by a spread when moving from one job to another are shipped to this central warehouse, to be requisitioned by other spreads when needed. Furthermore, periodically equipment must be sold or traded in on new and many of these units are assembled at La Vergne.

Some inventory is kept at the warehouse, generally consisting of supplies rather than parts, as machinery manufacturers have depots in Nashville where parts can be obtained readily.

A noticeable change in repair practice from a few years back is the fact that less hardfacing is being done. With better steel used nowadays in dragline and backhoe buckets, ditching machine and tractor rollers, and similar equipment, they hold up better. Another economic factor is the high wages paid today. Sometimes it is better to replace than to repair, but this is not always true. There is still considerable hardfacing of track rollers, usually performed in the yard in off-job overhauls.

Price management views its maintenance program as a commonsense approach to economic operation. In the past, techniques have been improved as new ideas developed and better equipment became available. An unswerving goal of placing only top flight equipment on the job, and openmindedness on how to attain it, will assure adoption of even newer methods if the need for them arises. ★ ★ ★



Mechanics overhaul a master clutch on a D-8 tractor.

Heavy cement coating solves

SOIL CONDITION PROBLEM

LEE J. MOREMEN ● JOE R. WILLIAMS
Pipe Linings, Inc.

SAN DIEGO Gas and Electric Company has under construction a 51-mile, 30-in. gas transmission line that, because of unusual soil conditions posed a problem in design.

Extending northward from the City of San Diego for a distance of 38 miles, the route of the pipeline is 1½ to 5 miles inland but paralleling the Pacific Coast, then turns inland toward the mountains and ends at the town of Rainbow, where it will receive gas from El Paso Natural via Southern Counties' Texas pipeline system.

Terrain generally is rolling with numerous arroyos, but the line in its first 25 miles crosses 11 different rivers and marshes. And this is where the design problem comes in. The soil at these locations is alluvial, being composed largely of fine sand and silt. It is highly soluble, and when saturated forms a fluid, high-gravity mud weighing an estimated 90 to 95 lb per cu ft.

During periods of heavy rainfall, the rivers develop swift currents, which may uncover or undercut the pipeline. Subsequent damage could be severe due to stresses set up by the force of the river current, abrasion, and the impact of tumbling boulders and rocks being carried downstream.

Solution in Beam Strength

Solution to the problem was to provide beam strength. Specifications called for ¾-in. wall pipe where the greatest river currents were expected, and ½-in. wall pipe at lesser current locations.

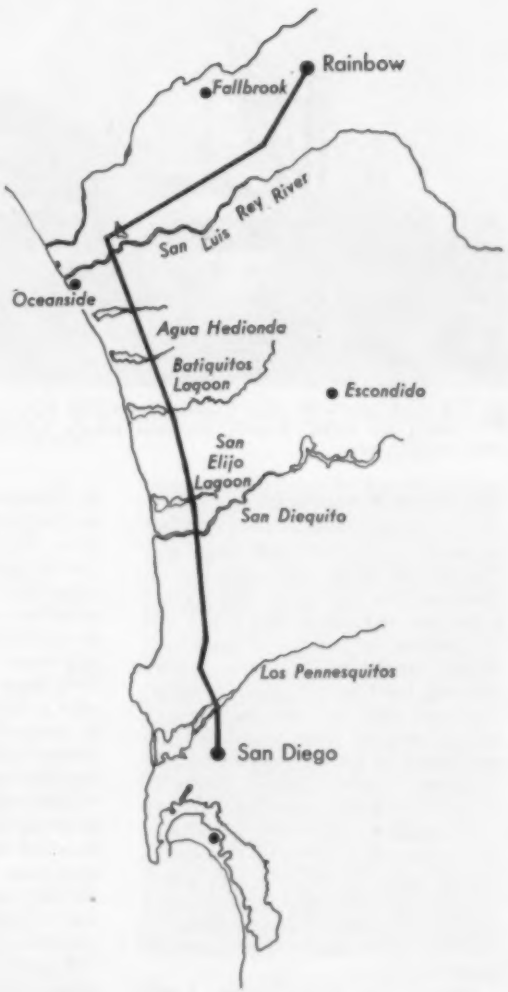
Specifications also called for a reinforced concrete jacket to provide negative buoyancy in the 95-lb fluid mud. To achieve this negative buoyancy on the ¾-in. wall pipe, a 4-in. concrete coating was required; the ½-in. wall pipe required a 6-in. coating. These thicknesses are considerably greater than is customarily required.

The ½-in. wall pipe with 6-in. coating weighs 844 lb per linear ft, and the ¾-in. wall pipe with 4-in. coating 674 lb per linear ft. A 40-ft random length of pipe will weigh approximately 16 tons and 12½ tons, respectively.

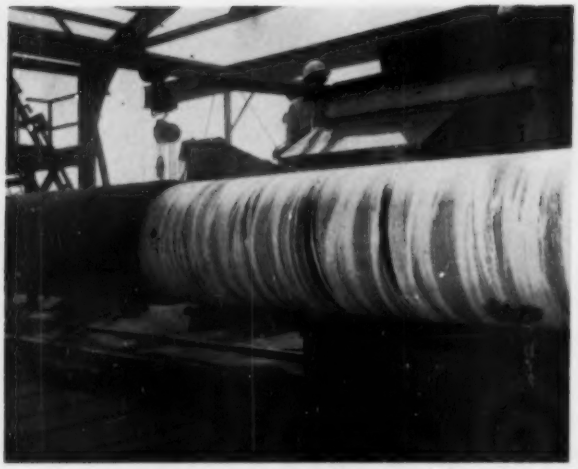
It is interesting to note, considering the difference in weight, that both types of pipe have equal negative buoyancy. The answer lies in the relative displacement of each.

Application Procedure

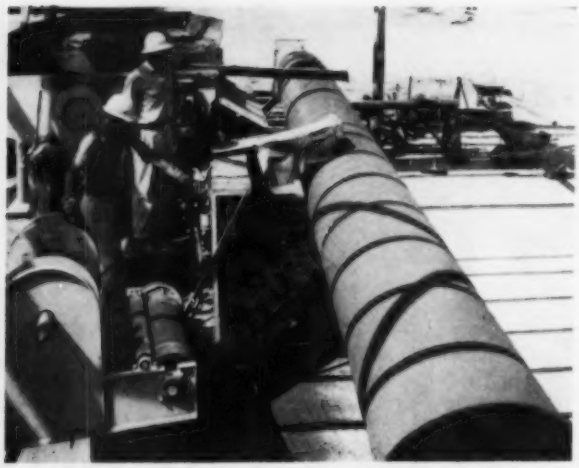
In all, 8100 ft of pipe was coated with Pliweight, an application of reinforced cement mortar applied by the brush coat process. The brush coat mixture is a rich cement mortar consisting of one part Portland cement to three parts aggregate, whereas "plain" concrete is one to five. The brush coat mortar is premixed in a batch plant and applied mechanically.



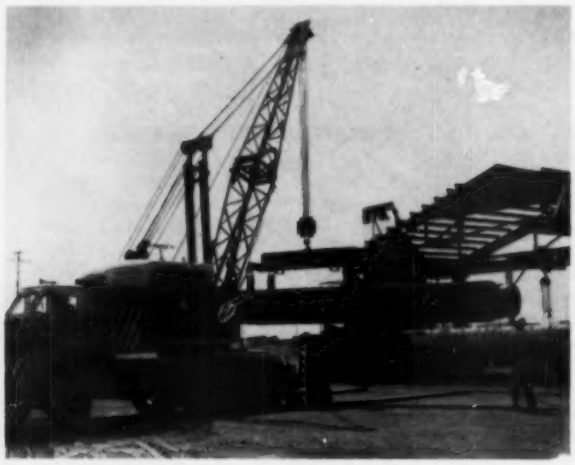
Route of pipeline between San Diego and Rainbow



1. 36-in. diam by ¾-in. wall by 40-ft long pipe with double coal-tar coat receiving the initial application of Pliweight concrete mortar.



2. After application of 1-in. thick concrete mortar, 2-in. by 4-in. by 13-gage wire mesh was applied under tension to give reinforcement.



5. A pipe joint with green coating is removed from machine, ready for curing. Coating denseness permits handling with slings though green.

6. California highway laws permitted only one pipe section per load. Cable slings were used on cured pipe with no damage to the coating.

This Is the Procedure:

The pipe is mounted on spindles and rotates in front of the applicating head. The mortar applicating equipment is mounted on a rail car running parallel to the pipe and carries with it, in a special hopper, a supply of pre-mixed mortar. Mortar is force fed to the applicating head by an auger conveyor. The applicator head consists of a pair of large, counter-rotating, serrated rubber wheels or brushes, revolving with a surface speed of approximately 90 mph. The cement mortar is mechanically projected by the brushes against the surface of the rotating pipe as the applicator car moves from one end of the pipe to the other. This results in a consistent, uniform dense coating of slightly more than 1 in. nominal thickness.

Over this first layer of mortar, a strip of steel wire mesh (2 in. by 4 in.—13 gage) 2 ft wide is helically wound under measured tension. The pipe is again revolved and the applicator car moves down the track applying the second layer of mortar. This is followed by another layer of reinforcing steel.

Job specifications require four layers of reinforcing mesh in the 6-in. jacket and three layers in the 4-in. jacket. Each layer of reinforcing mesh is tied off, cut in the clear, and the next pass of cement mortar is applied immediately. This process is continued until the required thickness is applied.

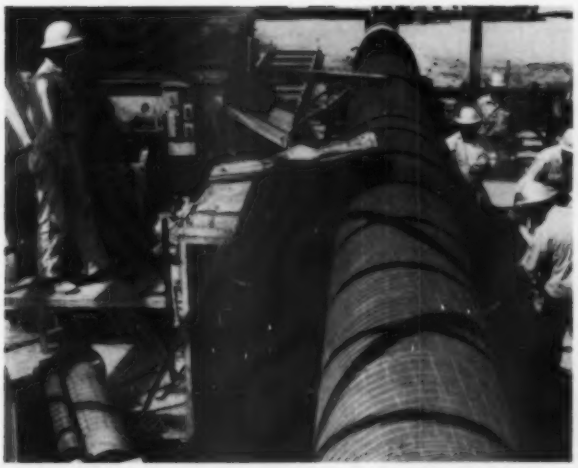
After the last covering pass of cement mortar is applied, careful circumferential measurements are made to determine whether the required weight has been applied. If not, another light pass of mortar is applied until the required weight is achieved.

Each joint of pipe is weighed on a public scale and is accompanied by a certified weight certificate when shipped.

Low Water-Cement Ratio

Close control of the water content in the mortar permits a relatively dry mixture; approximately 5 gal of water per sack of cement is used. This ratio assures complete hydration of the cement, a low water-cement ratio, and results in a mix that has the consistency of damp sand. The mechanical impact (90 mph) of the mortar against the pipe during application results in a green coating that is dense enough to allow the pipe to be handled immediately.

A 25-ton mobile crane, using a strong back and two 12-in. wide slings around the mid-portion of the pipe, lifts and removes it from the machine and transports it to the curing yard, scarcely leaving any noticeable marks in the surface of the mortar. The heaviest joint handled in this manner weighs over 16 tons, the lightest 12½ tons.



3. Second concrete mortar reinforced coating goes on. Specifications required four such layers for 6-in. jacket, three for 4-in. jacket.

4. Following final application the coating was measured to determine that correct amount of material was applied to meet specifications.

7. Here two sideboom tractors are moving a section of pipe weighing 15 tons into place in the field for the line-up and stringer bead.

8. Welding foreman J. Dunn watches line-up operation prior to welding. A pneumatic internal clamp was used to provide proper positioning.

After the application has cured for 12 hours, sprinklers are used to maintain the moisture content in the coating during the seven-day curing period.

California highway weight restrictions make it impossible to haul more than one 40-ft section per load. Two hundred trips will be required to complete this delivery.

Project Manager M. R. Engler, of San Diego Gas and Electric, specified a continuous, reinforced concrete coating in lieu of river weights or auger-type swamp anchors for the following reasons:

1. Extremely hot (electrolysis) soil conditions throughout the entire line could mean any unprotected metallic mechanical devices could fail due to corrosion.
2. Swamp anchors might become ineffective when needed most because the soil can become fluid when saturated with water.
3. River weights, mechanically attached or cast on the pipe, can in the case of washout, create undesirable eddy currents that aggravate the washing condition.

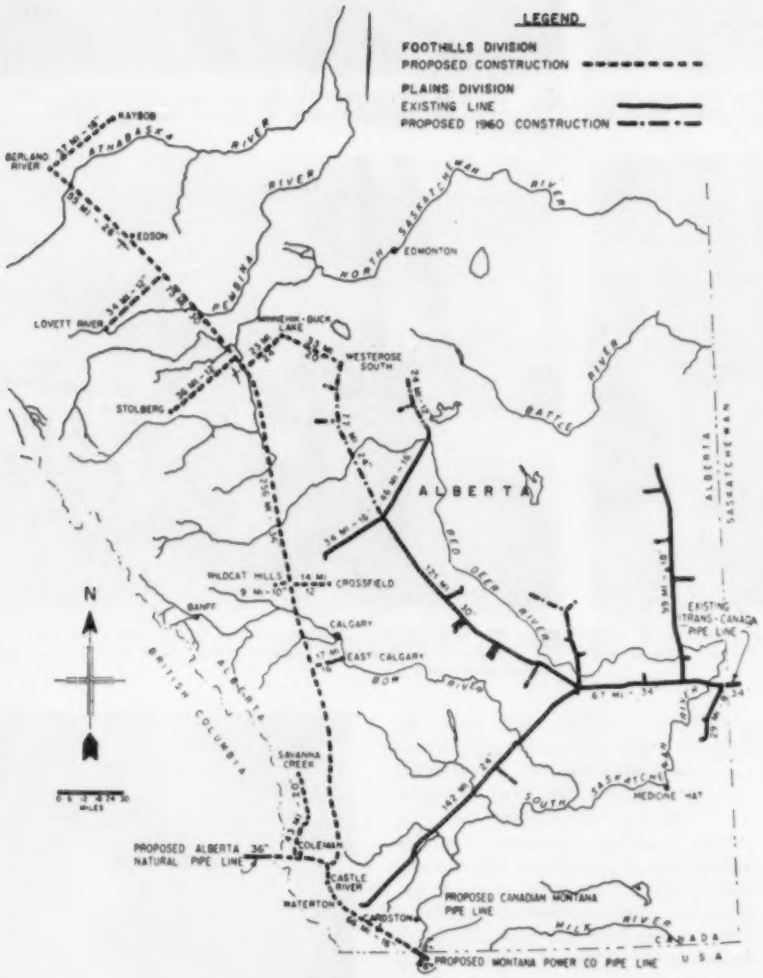
The installing contractor, Stanley Bledsoe Corporation, Tulsa, Oklahoma, estimated the job on the basis of applying the required continuous concrete jacket in the field. On first analysis, it would seem likely that the cost of trucking this heavy material an average of 95 miles could be saved by performing the work at the jobsite. The economics of plant application were such, however, that this method was the one eventually adopted.

Through the cooperation of the engineers of San Diego Gas and Electric; their consultants, the Bechtel Corporation; Stanley Bledsoe Corporation; and Pipe Linings, Inc., an economical solution to this company's interesting problem was found. * * *

9. After joints were welded, reinforced coal-tar coating was applied, then concrete poured about entire field joint to provide protection.

Good Year Shaping

LESLIE ORR ROWLAND, *Winnipeg, Canada*



Existing and proposed pipelines of The Alberta Gas Trunk Line Company system.

THE FIRST YEAR of the big Canadian natural gas decade has turned out to be a great disappointment for pipeline contractors. Approvals for the major gas export projects came too late in the season for any construction to be done in 1960, although 1961 is shaping up as a good year in comparison.

Main line construction was concentrated entirely in western Canada, for the first time in several years, and all but an insignificant amount of mileage was in natural gas pipelines. Several projects which had been planned tentatively for this season were either cancelled or deferred indefinitely, so that total mileage for 1960 will come to considerably less than in 1959, which was one of the top three years for construction activity.

Intense competition among numerous contractors for the relatively small volume of business reduced footage bids to a level at which there was very little profit margin. Luckily (for pipeliners) the summer season brought the worst drought for many years across the prairies, and the only delaying hazard turned out to be, not the expected wet weather, but the risk of being blown out by dust storms. All the spreads that were at work in the prairie provinces during the summer experienced a phenomenal season of record footages and almost no down time. All jobs were finished well ahead of schedule.

Because of the close figuring on all bids, the successful contractors, with

2500 to 3000 miles of new construction estimated for 1961, which would make it Canada's best year except for 1957 and 1958 when the big cross-country gas lines were built — 1960 has been disappointing

Up for Canada

Coating and wrapping Trans-Canada's 30-in. line that will deliver export gas to the U. S.-Canadian international boundary near Emerson, Manitoba.

only one exception, ran their spreads on a poor-boy organization with minimum equipment and no staff frills. The exception was the case of a contractor who had a big-inch spread held over from a major job last year and put it to use on three separate contracts, one on a northern Alberta gathering system job, one on the only big-inch job of the season, and the third, due for completion late in October, on a short section of loop.

Gas Lines Lead

Although natural gas main transmission and lateral construction was far below 1959, and even farther below the record-breaking 1958, it still managed to run more than double the mileage of oil lines. An approximate total of 766 miles of gas lines was laid during the summer, including another small project started with a view to completion before the end of the year. Oil lines, consisting entirely of gathering systems excepted for one small section of main line loop in north central Alberta, added up to 346 miles, including one small construction job that got under way at the end of September for completion by December 1.

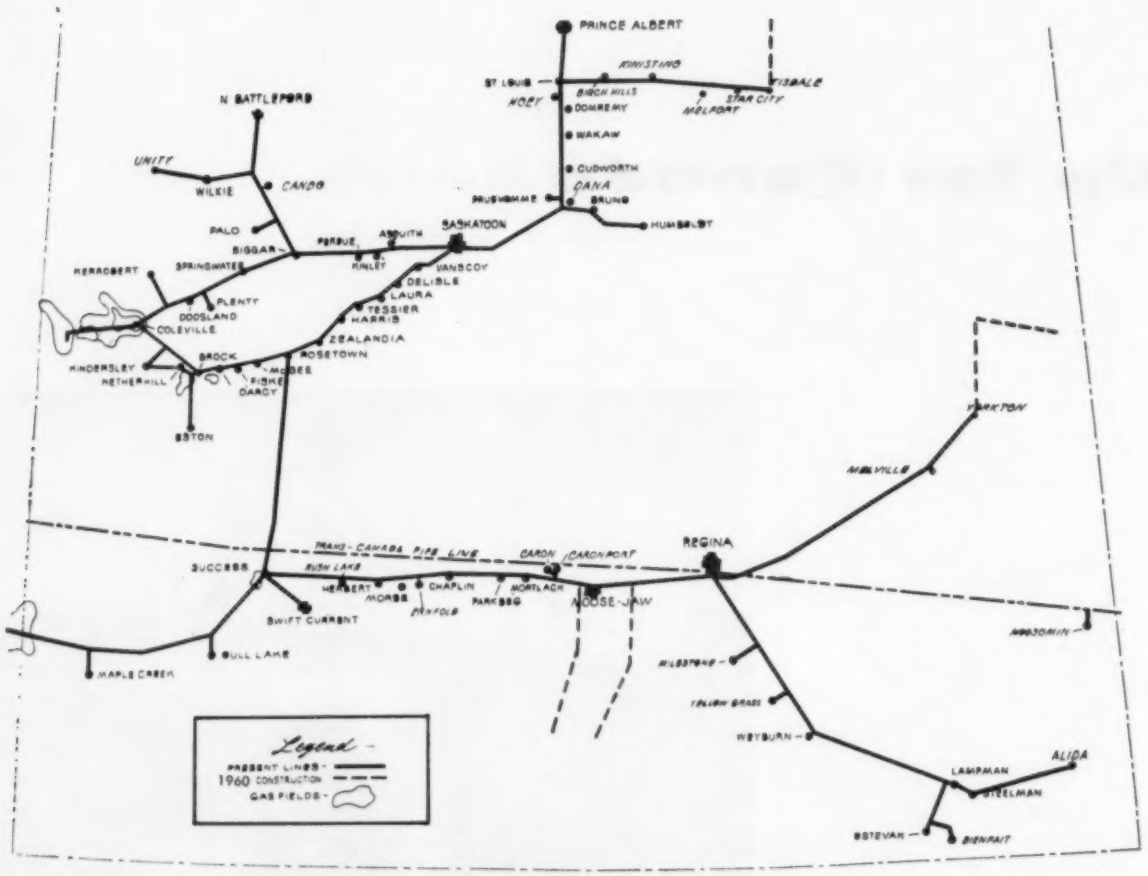
The only big-inch job of the year was 50.7 miles of 30-in. gas line in southeastern Manitoba, comprising the export lateral of Trans-Canada Pipe Lines, Ltd. In Alberta the biggest item, and largest across Canada after the Trans-Canada job, was the main line extension of The Alberta Gas Trunk Line Company, Ltd., 72.5 miles of 24-in. pipe from Torrington Junction, in the west central part of the province, to the Homeglen-Rimbey gas field 75 miles southwest of Edmonton. Laterals added 110 miles.

Saskatchewan Power Corporation extended its provincial grid gas distribution system in Saskatchewan, with approximately 243 miles of main line extensions and laterals. The schedule included 112 miles of main line and 131 miles of laterals, as the corporation added 24 communities to its total, bringing cumulative communities on the system to 92 cities, towns, and villages.

In British Columbia, Westcoast Transmission Company, Ltd., laid approximately 90 miles of new laterals, in preparation for greatly increased deliveries through the winter and next summer. Eastern Canada had a severe slump, as the principal utility companies, concerned about depression factors in the economy and reluctant to raise new capital at prevailing high interest rates, cut back their operations to what they could do out of retained earnings. Only about 100 miles of new laterals were laid, to tie in a few new communities to existing main lines.

Oil Line Construction

The oil line jobs included principally 112 miles in the Swan Hills oil field area, consisting of both main line loop and gathering line extensions; 70 miles in the Pembina field, all gathering extensions; another 100 miles of gathering line extensions in various minor fields in Alberta; and 66 miles



Extension of Saskatchewan Power Corporation's system was one of the largest construction programs in Canada this year.

of gathering system extensions in southeastern Saskatchewan for Producers Pipelines, Ltd.

Banister Construction Co., Ltd., Edmonton, made almost a clean sweep of the western prairies, as it got the entire Alberta Trunk program, except for one river crossing, which went to Mannix Company, Ltd., Calgary. Besides its 182 miles in Alberta, Banister got the entire Saskatchewan Power main line extension program and the related laterals, a total of 152 miles. Its total of about 334 miles was thus half the total gas mileage in the west and nearly one-third of the over-all total of about 1100 miles for oil and gas lines combined across Canada. It laid 46 miles of oil lines in Saskatchewan, thus aggregating 380 miles or more than one-third of total.

Majestic Contractors, Ltd. was second in volume, with the big Trans-Canada job and the entire Swan Hills oil line project, for a total of 162 miles. Robb Construction Company, Ltd., Regina, was third with its 91 miles of laterals for Saskatchewan Power in southern Saskatchewan.

These figures would be varied, of course, by the contracts not yet awarded at the time of writing, but the late contracts will not materially affect the relative standings.

The Outlook

Between late seasonal construction through the fall and early winter of 1960, and assured contracts for 1961, contractors are looking forward to a much better run of business in the next 14 months.

In British Columbia the first main crude oil pipeline to serve the northeastern oil fields will be laid for Trans-Prairie Pipe Lines, Ltd. The contract was scheduled to be awarded by the end of September or early in October, for completion in the summer of 1961, with one portion to be in operation by December 1. It will consist of 130 miles of 6-in. and 8-in. pipe, including laterals from the four principal oil fields in the area, and the main line connecting them with the two small refineries at Taylor and Dawson Creek.

The first phase of construction of a 250-mile extension of the British Columbia gas gathering system, to bring gas from the Fort Nelson fields to the processing plant at Taylor, where the Westcoast Transmission main line takes off for Vancouver, is scheduled for completion in 1961. Contract was to be let early in October for the first 50 miles, comprising the southern part of the main line extension. Owner is Gas Trunk Line of British Columbia, Ltd., a close affiliate of Westcoast and of its parent company Pacific Petroleums, Ltd., major gas reserve owner in the area.

Ultimately, by the end of next season's construction, the main line of 30-in. diam will be in the ground for the full 250 miles from Fort Nelson to Taylor, and an undetermined amount of lateral lines will have been laid.

Initial capacity will be 350,000,000 cu ft per day, and plans are being made for expansion to 650,000,000, subject to approval by the National Energy Board and the Federal Power Commission of applications by Westcoast for increase in its export permit quantity.

This will be followed in 1962 by a loop of the entire main line, to bring

its capacity into line with that of the gathering system, if the applications are successful next year.

On the Alberta side, the foothills system of The Alberta Gas Trunk Line Company, Ltd., will be the biggest gathering system ever laid in Canada. Tenders were called for early in October and the contracts let in time for a start on right-of-way work during the winter. A large part of the route, along the east slope of the Rocky Mountains, consists of muskeg and swamp, which can be traversed best in winter when frozen solid, especially for grading and stringing.

The specifications provide for 386 miles of main line, from 24-in. to 36-in. diam, and 312 miles of laterals from 24-in. down to 10-in., for a total of 798 miles of pipe. It is estimated that, according to exact cut-off date for engineering design, as many as 12 spreads may be needed to ensure completion by the deadline date of November 1, 1961. By far the largest part, 256 miles, will be 36-in. pipe, and this will be the biggest-inch pipe laid in Canada to date.

Related to this project, and contracted about the same time, was 108 miles of 36-in. line across southeastern British Columbia. Owned by Alberta Natural Gas Company, this line will carry export gas for California and the Pacific Northwest to the border-crossing point between Kingsgate, B. C., and Eastport, Idaho. The owner company is a jointly owned subsidiary of Pacific Gas and Electric Company of San Francisco and Alberta and Southern Gas Company, Ltd. of Calgary.

An undetermined amount of gas line construction will be done by the two Alberta utility companies, Canadian Western Natural Gas Company, Ltd., and Northwestern Utilities, Ltd., probably at least 80 to 100 miles of new laterals.

In Saskatchewan, the power corporation will extend its main line grid for at least another 100 miles and will lay laterals to about another 20 to 25 communities, involving possibly 150 to 200 miles of smaller diameter line.

Field gathering lines in the foothills region of Alberta, to connect existing and planned gas wells to the Alberta Trunk system, may amount to as much as 200 miles.

In eastern Canada new laterals can be expected to total some 150 to 200 miles.

Altogether the gas line construction program for 1961 is shaping up as a substantial figure of nearly 2000 miles of main transmission lines and laterals. Oil pipeline construction will again be slow, as the only items in prospect are 150 to 200 miles of field gathering lines in British Columbia, Alberta, Saskatchewan, and Manitoba. Main line construction appears to be a dead issue for 1961, except for the possibility of completion of the loop of the Swan Hills line (Federated Pipelines, Ltd.). This would take about 50 miles of 12 to 16-in. pipe, but its timing will depend on progress of oil markets, at present not very encouraging.

Virtually assured for 1961 is a major construction program of gathering lines for wet gas liquid products in Alberta. These liquids will be produced of necessity from the wet gas fields as soon as gas export to the western states begins, late in 1960. Several plans are before the provincial conservation board, but whichever one is approved will involve at least 400 to 500 miles of small to medium sized lines to gather an estimated initial volume of 50,000 bbl per day with a rapid growth to 75,000 bbl per day by 1963.

This products line system may become one of the major networks in Alberta within a few years and should provide steady work for contractors in its expansion.

Putting all the certainties and contingencies together, it is possible to forecast upward of 2500 miles of all types of main pipelines, laterals, and gathering systems. It is quite likely that the total may reach 3000 miles, and this would make 1961 the best pipeline construction year in history with the exception of 1957 and 1958 when the big-inch cross-country gas lines were in their heaviest construction phases.

It looks like an extremely good year ahead, with bid prices firming up a bit and practically full employment for the domestic pipeline construction contractors.

Trans-Canada's Big-Inch

The only big-inch contract of the 1960 season was the export lateral gas transmission line of Trans-Canada Pipe Lines, Ltd., from the Ile des Chenes compressor station 15 miles southeast of Winnipeg to a point on the international boundary about six miles east of Emerson, in southeastern Manitoba. This job, consisting of 50.7 miles of

Six pipelayers and a sideboom tractor walk-in a 160-ft section of creek crossing pipe.

Two pair of hot pass welders averaged 10,000 ft of pipe a day on Emerson extension of Trans-Canada line.

30-in. pipe, was awarded to Majestic Contractors, Ltd., of Toronto and Edmonton.

Thanks to the driest summer in many years in Manitoba, the job was welded out in only 28 days, averaging nearly 10,000 ft per day for total days worked. Only a few partial days were lost because of rain showers.

Vice President C. A. (Cal) Callahan was in charge of the job, with K. B. (Rusty) Killingsworth as spread superintendent. John Gates was office manager. Foremen were: ROW and ditch, Manuel Gier; bending, Billy Wisdom; pipe gang, Hank Putty; welders, Bill Morris; dope, Cecil (Poss) Kirksey; tie-ins, Bronc Pierson; cleanup and backfill, Lionel Wiedmer. Chief inspector for Trans-Canada was Ralph Kilmer.

The route of the lateral was over ideal pipelining country. Most of it is level farmland and the soil alternates between rich black earth and sandy loam with not a single boulder on the whole route. There are a few farm irrigation and drainage ditches, but none more than 2 or 3 ft deep. Ditching went right through them, and then a clam was used to deepen the ditch enough to provide the mandatory 3 ft of cover over the pipe below the ditch bottom. There were two major creek crossings, both requiring separate crossing sections with river weights.

Right-of-way kicked off on June 20 and was finished on July 3. Minimum clearing and grading were required, and most of the work was on approaches to road crossings and the two creek crossings.

Stringing was subbed to Canadian Parkhill Pipestringing, Ltd., of Toronto, under superintendent John Nitschke. Access roads ran parallel to the right-of-way for almost the entire route. They were seldom more than 100 ft from the ditch line and never more than half a mile.

The only difficulty was a lack of railway sidings along the rail line, which also parallels the pipeline route. At the longest distance, the stringing trucks were running on a 108-mile total turnaround. Stringing started on June 23 and was completed on July 30. The crew averaged nearly 7000 ft per day, using six stringing trucks, one truck-mounted crane and a sideboom tractor on the railway sidings, and a single sideboom tractor on the right-of-way. Ground conditions were so good that the trucks ran under their own power all the time. Parkhill said he could have made better time except for the presence of a large number of short pipe joints, which were salvaged from parts of the Trans-Canada main line construction job in Ontario.

The ditch kicked off on July 2 and the pipe gang and welders on July 5. Ditching was done with two ditchers, running leapfrog on single shifts and averaging more than 6000 ft per day each. They worked with wide-angle slopers to prevent caving of the heavy soil. Hardly any clamming out was needed except in an occasional boggy place and at road crossing approaches. The ditchers were followed closely by the bending gang and the pipe gang, to avoid having much open ditch ahead of the pipe. Few bends were needed, except for drainage ditches and road crossings.

The pipe gang used the same two double twin arc welding units mounted on sideboom tractors that have been with the spread since the fall of 1956 when it was the first spread in Canada to use them on an experimental basis on the Trans-Canada main line (34-in. pipe).

Three stringer bead men were employed, with two pair of hot pass welders. Average footage was over 10,000 ft per day worked. With a high proportion of short random length joints this was considered exceptionally good.

There were 16 welders on the firing line, 15 on payroll and one contract welder with his own rig. Welding machines were all mounted on rubber-tired wagons. Light farm-type tractors with big rubber tires were used for towing.

The dope gang kicked off on July 6 and the line was doped out on August 4. The gang was set up with extra heavy equipment for an average run of 8000 ft per day, but actually kept right on the heels of the pipe gang and averaged nearly 10,000 ft.

Some of the pipe had been wrapped previously and some of it had a good deal of rust scale from lying in stockpile for two years or more. To handle the extra cleaning required to remove the old wrap and rust, the dope gang used two cleaning and priming machines, with two pipelayers on the front end.

The back end of the dope gang employed two more pipelayers. Most of the line was coated with bitumastic enamel, but a small portion was asphalt doped. Inner wrap was glass fiber and outer wrap asbestos felt. Pipe generally was cradled into the ditch from the wrapping machine, except when asphalt dope was used, when it was skidded. On these sections the tie-in gang lowered early in the morning, along with the slack loops.

Tie-ins were far apart, because of the good topography. Most of them were made only at road crossings, which averaged about a mile apart. Total tie-ins averaged about four or five per day. The tie-in gang had two pipelayers and a tractor that hauled the welding rig on an Athey wagon with a swivel hitch.

Four clams were used on the spread, mostly for road crossings, a few swampy places where the ditch caved a little, and the two big creek crossings. One was attached to the tie-in gang most of the time, to dig road approaches and bellholes for the tie-in welders.

Water Crossing Technique

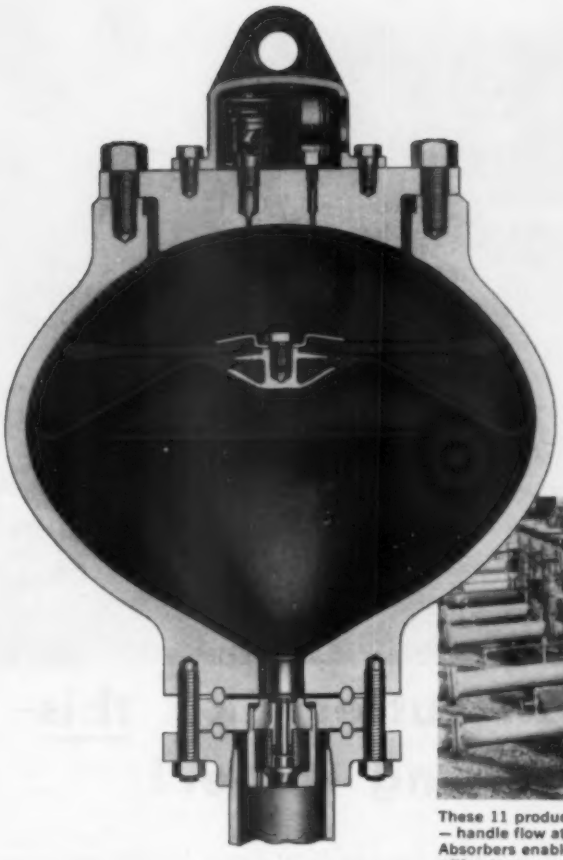
The larger of the two creek crossings went in very easily, in about 20 minutes after the section started to move into the water. Six pipelayers and a sideboom tractor were used to pick up the 160-ft section, which had 14 double split-collar type reinforced concrete river weights bolted on. It was coated and wrapped conventionally, with an extra outer wrap of asphaltic material.

For this crossing the contractor had to contend with 9 ft of water and a fast flow of about 5 to 6 mph, although the original width of the creek was no more than 40 ft. The ditch had to be cut at least 6 ft into the bottom of the creek bed, to provide the mandatory 3 ft of cover.

A start was made by bulldozing an earthen dam on the downstream side of the right-of-way to a height close to water level. Then three pipe joints were laid side by side, parallel to the direction of flow, to form a culvert, and the dam was raised and widened to make a right-of-way that could be walked over by all the equipment on the spread. The dam also raised the water level on the upstream side to a depth of about 15 ft and made it almost static. As there was considerable silt coming down with the strong current, ditching with two draglines, working from opposite sides, had to be carried on continuously until the crossing section was actually being pulled in.

The excavated earth from the creek bed was piled on both sides of the banks. To keep the dam clear for travel, two bulldozers were employed steadily to push away excavated material as fast as the draglines could dump it. The ditching started at dawn on the morning of the pull, and was completed by 6 p.m., but both draglines kept working on cleanout of drifting silt until 7:30 p.m. when the section was moved into the water.

Backfilling was completed the next day. Because of the danger of current washing away the approaches on both sides, especially in spring run-off periods, both banks were packed solidly with sand bags in riprap fashion. These are expected to settle in as time goes



prolongs life of pipelines, fittings and pumps... saves downtime... cuts maintenance costs!

These 11 product transfer lines — some over 1,000 feet long — handle flow at the rate of 1,600 gpm each, yet Hydril Surge Absorbers enable them to be closed in a fraction of a second without over-pressuring lines, fittings or metering equipment.

HYDRIL TYPE "K" SURGE ABSORBER

smooths out shock and pulsation in pipelines

QUICK-CLOSING VALVES and piston-type pumps punish pipelines by imposing sudden peak pressure loads. Unless these surges can be absorbed or smoothed out, pipe and fittings are exposed to stresses which may cause costly failure.

Hydril Type "K" Surge Absorbers are successfully controlling many types of line surge and pulsation in petroleum product handling lines, water pumping systems and oilwell repressuring programs. Simple design and construction assures long, trouble-free operation. This same oil field-proven Hydril design has been used for many years as a pulsation dampener on high-pressure oilwell mud pumps. Servicing, though rarely required, is readily performed without special tools and without shutting down the system or removing the unit from the line. Available in a wide range of sizes and pressure ratings.

Another dependable Hydril pressure-control product

HYDRIL COMPANY

If you need a brush cutter like this– we've both been missing a bet!

We're a little ashamed to admit we've never tried to sell the pipe line industry these cutters. You see, Servis Equipment Company *originated* the tractor powered brush cutter. And as the picture indicates, ten years later we're still producing the most rugged cutters made.

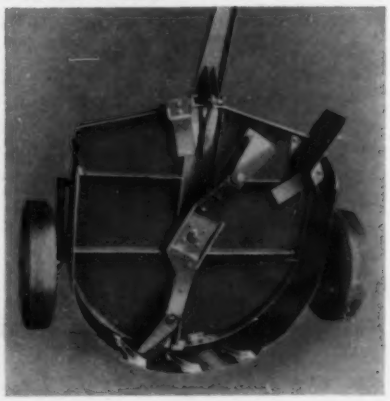
Sticking too close to the farm has been our trouble. Of course, we *have* sold to state highway departments and to the Air Force, but the red tape was so involved that we found it more efficient to concentrate on the farmers . . . even in South America and Africa.

A pipe liner in West Texas bought one of our Gyro 66 Brush Cutters the other day. It cut up tough mesquite brush on his right of way like nothing had before. He was so enthusiastic, he said we ought to tell other pipe liners about it, gave us the name of this publication.

It's true, Servis cutters will take on the toughest job — we've demonstrated them on a row of 4" x 4" posts. The secret is in low tip speed, but extra heavy blade assembly for tremendous momentum.

We have dealers from Carlsbad to Caracas. There's one near you. Clip the coupon and send for his name.

Underside shot shows heavy construction. A-shaped blade carrier, optional extra blades for fine shredding.



Servis EQUIPMENT CO. DALLAS, TEXAS

Servis Equipment Company Dept. E
1000 Singleton Blvd.
Dallas, Texas

Please send me information on items checked.

Name_____

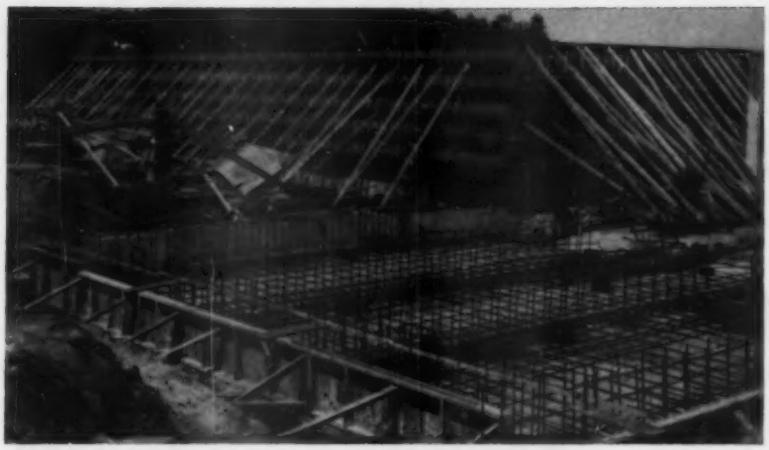
Address_____

City_____ State_____

Type Tractor Owned_____

- ☐ Gyro 140" Shredder (Pull-type)
- ☐ Gyro 84" Brush Cutter (Pull-type)
- ☐ Gyro 66" Shredder (Pull & lift models)
- ☐ Gyro 60" Shredder (Pull & lift models)
- ☐ E 60" Clipper (Pull & lift models)
- ☐ BH 60" Mower (Belly mount)
- ☐ Pasture Renovator
- ☐ Whirlwind Terracer
- ☐ Hudson Automatic Row Marker
- ☐ Dump-type Rake
- ☐ Soil Scraper
- ☐ Lone Star Blade (light, 6')
- ☐ 3-Way Ditcher-Terracer Blade, 6'
- ☐ Heavy Duty 3-Way Blade, 7'
- ☐ No. 7 Angledozer (w/Brush Rake at'chmt) (Row crop tractors)

"Make Pay Dirt Pay More — Join Your Soil Conservation District"



Wooden piling was driven 18 ft into the ground and reinforced concrete poured to a depth of 2 ft to form foundation and basement at Portage la Prairie where station site is underlain with quicksand.

on, so that the approaches will be almost proof against water erosion.

Compressor Stations

Most of the capital budget of Trans-Canada Pipe Lines, Ltd., for 1960 went into the construction of ten new compressor stations and additions of single units to two existing stations. The entire job cost about $30,000,000, including supplies, land acquisition, and contract prices. The ten new installations added 69,010 hp to the system, increasing total compressor station capacity to 144,510 hp as of the end of the construction program. Throughput capacity for the coming winter will be 700,000,000 cu ft per day out of the input end of the line at Burstall, Saskatchewan, and 430,000,000 east of Winnipeg after providing for domestic deliveries across the prairies and the export south from Winnipeg.

Here are the individual contract data:

Station No. 2, Burstall, Saskatchewan, addition of one reciprocating unit of 3400 hp. Contractor: Marwell Construction Company, Ltd., Vancouver. Cost: $765,000.

Station No. 5, Cabri, Saskatchewan, new station, 8370 hp, single gas turbine unit. Contractor: Marwell Construction Company, Ltd., Cost: $3,472,000.

Station No. 9, Herbert, Saskatchewan, new station 8370 hp, single gas turbine unit. Contractor: Brown and Root, Ltd., Edmonton. Cost: $3,472,000.

Station No. 17, Regina, Saskatchewan, new station, 8370 hp, single gas turbine unit. Contractor: Perini Western, Ltd., Toronto. Cost: $3,472,000.

Station No. 21, Grenfell, Saskatchewan, new station, 8500 hp, single gas turbine unit. Contractor: Canadian Kellogg Company, Ltd., Toronto. Cost: $3,511,000.

Station No. 30, Rapid City, Manitoba, new station, 8500 hp, single gas turbine unit. Contractor: Catalytic Construction Company, Ltd., Sarnia, Ontario. Cost: $3,428,000.

Station No. 34, Portage la Prairie, Manitoba, new station, 8500 hp, single gas turbine unit. Contractor: Poole-Pritchard Canadian, Ltd., Calgary. Cost: $3,428,000.

Station No. 105, Ramore, Ontario, new station, 5000 hp, reciprocating units (two). Contractor: Montreal Engineering Company, Montreal. Cost: $3,445,000.

Station No. 49, Kenora, Ontario, new station, 7500 hp, three reciprocating units. Contractors: Mannix Company, Ltd., Calgary. Cost: $3,807,000.

Station No. 68, Port Arthur, Ontario, 2500 hp single reciprocating unit added. Work done by Trans-Canada maintenance staff. Cost: $513,000.

The scheduled completion date of all the jobs was October 1, with all jobs finishing ahead of schedule. Weather in almost all locations was the best in many years, especially across Saskatchewan and Manitoba where 1960 was a drought year.

Water Supply a Problem

The most unusual aspects of the station construction jobs were the general lack of availability of sufficient water supply, and three instances of special problems with foundations because of difficult types of subsoil conditions.

At only three of the eight sites was there enough water in the ground to make the drilling of supply wells practicable. Water is required in fairly large quantities for station cooling, heating, fire protection, and domestic supply to the company houses, as nearly all the sites are remote from towns or villages. Where possible two wells were drilled at each station, with one reserved for standby use. This was the case at Cabri, Grenfell, and Ramore.

At Herbert, a good water supply was found at a distance of 1½ miles from the station site. At Regina and Rapid City the company resorted to installation of gigantic impoundment dugouts. The prototypes, although of much smaller size, were the farm dugouts created during the drought years of the 1930's by the Prairie Farm Rehabilitation Administration. These have proved very successful for impoundment of water over long periods. In the case of the Trans-Canada stations, capacity of 2,000,000 gal was required for each. They were bulldozed to a depth of 24 ft.

The water supply to the dugouts is being provided, in the case of Regina, by diverting a nearby creek, and at Rapid City by interconnection of several shallow sloughs to drain into the dugout. At Portage la Prairie, well points were sunk into the ground because the water table is too shallow to support a normal well. At Kenora, the only point where the station sits on solid impervious granite rock, water is being drawn from under a nearby creek bed by pumping.

Deep pilings were used at the remaining two stations, to overcome problems of unstable soil under the site. The Portage la Prairie site is underlain by quicksand, which has an angle of repose of almost horizontal, making excavation difficult and affording no support for foundations.

Creosoted wooden piles were driven to a depth of about 18 ft to form the basement foundations, and a solid reinforced concrete slab was poured around them on the surface, to a depth of 2 ft, under the entire main compressor building. Auxiliary buildings were piled similarly. At Ramore, where the site is underlain by loose glacial till and some muskeg and surface water, concrete pilings were poured into steel tubes to a depth of 18 ft below the basement foundations.

A unique problem was presented by the Kenora station, which is situated on top of the highest outcrop of solid granite in the area. About 3000 cu yd of rock had to be blasted out of the location, mostly for ditching and grading of the station site. This is one location that is absolutely assured of no foundation settlement problems. Drainage channels had to be bored through the rock on the site, as the contours of the location form a large recessed bowl with no natural drainage at all, which makes a perfect reservoir for run-off water. ★ ★ ★

European pipelines recently completed and projected.

Launching a section of a Mediterranean pipeline by floating the pipe out to sea buoyed by barrels and towed by an offshore tug. The barrels were released when a full section of the pipe was positioned and the pipeline lowered to its position on the seabed.

EUROPEAN PIPELINES

. . . *planned on International basis*

Broadening network has as aim adequate supplies for industry and defense of countries west of the Iron Curtain

F. C. LIVINGSTONE
London, England

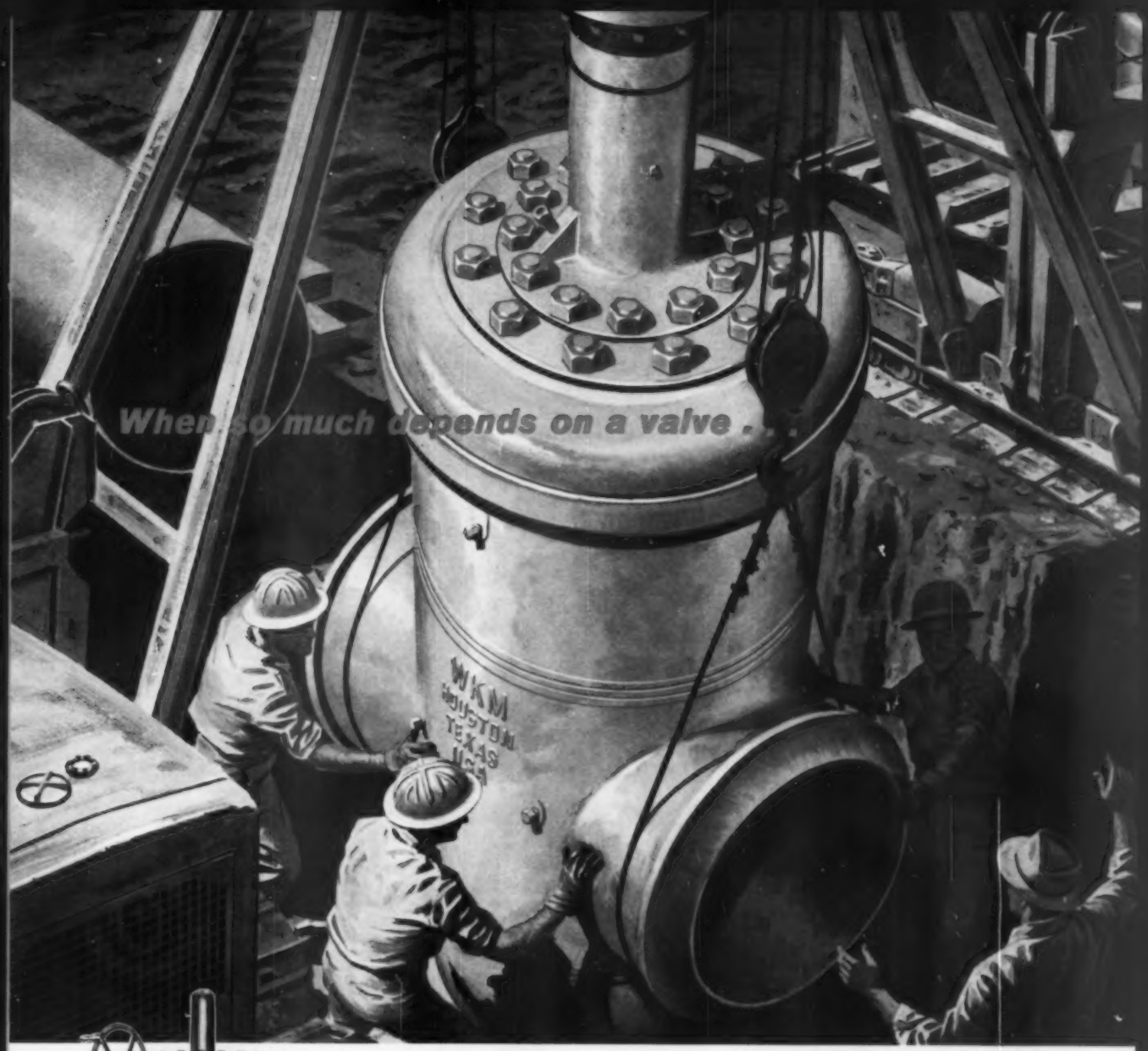
IF THE COUNTRIES of Europe have learned one thing from the cold war that has been threatening them for more than a dozen years it is that they are no longer self-sufficient units, existing in air-tight compartments behind their various frontiers. They have been forced to combine for their own defense into the North Atlantic Treaty Organization, and for commercial purposes they have formed the European Common Market and its counterpart, the "Outer Seven."

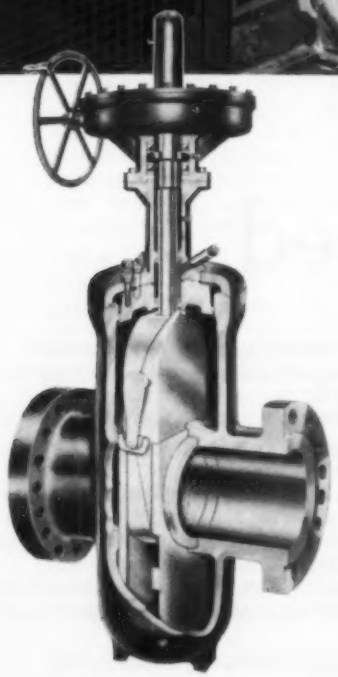
Before World War II, practically the only real international links between European countries were the railroads, the airlines, and the telephone and telegraph services. Today the picture is quite different and pipelines for oil, refined products, and gas, are now planned on a true international basis.

Because Europe itself produces little petroleum, it is understandable that the pipeline networks are based on the ports at which tankers arrive from the Middle East and other oilfields that pour their product into Europe.

This survey is intended to give a brief but complete picture of what Europe is doing to ensure that all countries west of the Iron Curtain receive an adequate supply of oil to maintain the industries of the individual countries and, if necessary, the defense forces of West Europe as a whole.

All told, the cost of the pipelines now being built or brought into operation is likely to be in the neighborhood of $300,000,000. This figure, of course, is quite apart from the cost of the new refineries along the pipelines.





W-K-M Expanding Gate Valves seal positively with *controlled force*

You exert unique control over the seating in W-K-M Expanding Gate Valves. Fully opening or closing the gate causes it to *expand*. So you can make as tight a seal as you want . . . first Teflon-to-metal, then metal-to-metal.

This extra degree of control insures maximum dependability over long periods of use or disuse . . . under a wide range of temperatures and pressures . . . with all pipeline ladings.

The exclusive W-K-M Expanding Gate is a big reason why W-K-M pipeline valves outnumber any other valve in mainline service. Specify them.

Exclusive expanding gate is full-bore, seals positively upstream and down.

Sizes: 2" through 12" at leading supply stores; sizes through 36" on special order.

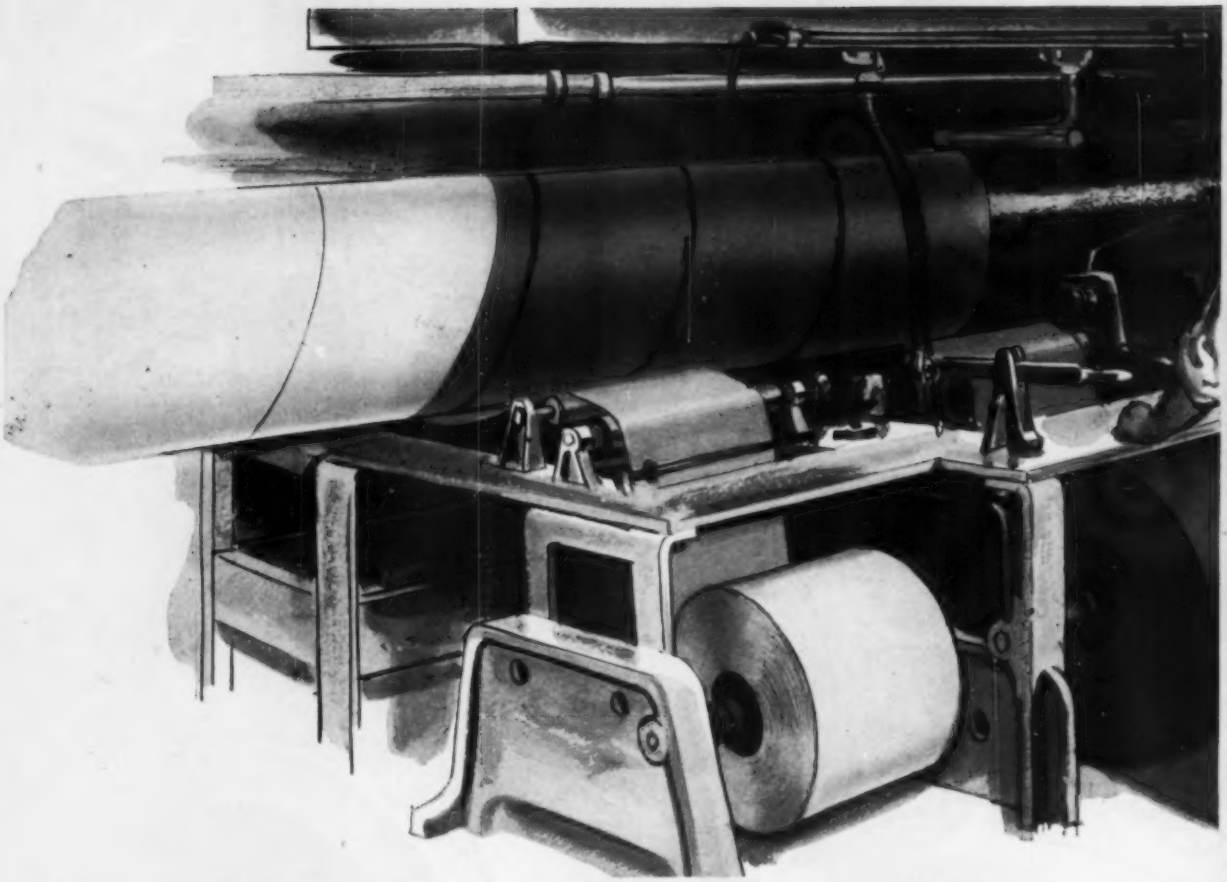
Pressures: ASA 300 through ASA 1500 lb.

W-K-M

DIVISION OF ACF INDUSTRIES INCORPORATED

P. O. BOX 2117, HOUSTON, TEXAS

6003



Specify Johns-Manville Partners in Protection for all your pipe– mill or field wrapped

J-M BLUE FLAG for enamel reinforcement

J-M ASBESTOS FELTS for a tough outer shell

J-M FLEXIBLE ROCK SHIELD for added protection against hazards of rugged, rocky terrain

When you specify the Johns-Manville system of pipe protection, you're sure of the maximum security for your lines. Both J-M BLUE FLAG and J-M ASBESTOS FELTS are designed with modern, high-speed wrapping machinery in mind. And you get all these advantages:

- **TROUBLE-FREE APPLICATION**
  –no unusual or complicated requirements
  –long rolls of wrap mean fewer stops
- **PERMANENT BOND WITH THE PIPE**
  –no pressure-sensitive adhesive to deteriorate
  –no voids under spiral laps
  –no moisture migration
  –no "operating room cleanliness" of pipe required to secure a good bond

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

MEET **3** PARTNERS IN PIPELINE PROTECTION FROM JOHNS-MANVILLE

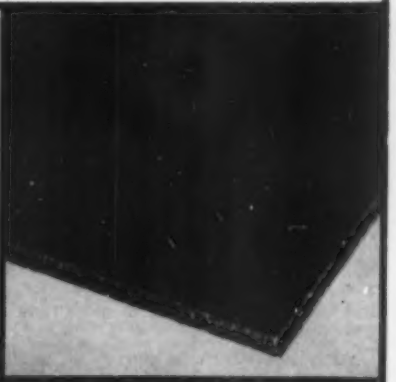
1

J-M BLUE FLAG Fiber Glass Wrap is a mesh of reinforced glass fibers that cannot rot, decay or absorb moisture under ground. Blue Flag lets enamel bleed through evenly until the wrap becomes an integral part of the coating. Uniform porosity prevents "holidays" as it assures consistent build-up.

2

J-M ASBESTOS FELTS, impregnated with either asphalt or coal-tar, are available in several weights to meet varied job requirements. These asbestos felts provide a flexible covering of stone, and have served as a tough outer shell on pipelines throughout the world.

3



J-M FLEXIBLE ROCK SHIELD is an asphalt-mastic composition board with a laminated felt surface. Its flexibility conforms to any pipe size, and its resilience provides the cushioning required in rugged rocky terrain.

- **DEPENDABLE RESISTANCE TO DAMAGE**
  –during handling
  –during backfilling
  –throughout the life of the pipe, J-M Blue Flag plus J-M Asbestos Felts give proven protection against soil pressures and chemicals . . . assure successful, low-cost operation of cathodic protection

- **FOR UNUSUAL CONDITIONS,** there's one more J-M Product you can use–a *third partner in protection*–J-M Flexible Rock Shield. It cushions the lines against rock penetration during backfilling and in service. J-M Flexible Rock Shield provides more dependable, lower-cost protection than dirt-padding, and conforms readily to all pipe sizes.

For further details about Johns-Manville Pipe Wrap materials–*three partners in pipeline protection*–see your nearest J-M Representative, or write to Johns-Manville, Box 158, Dept. PE 1160, New York 16, N. Y.

JOHNS-MANVILLE

JOHNS MANVILLE JM PRODUCTS

BLUE FLAG is a registered trademark of the Johns-Manville Corporation

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

It is foreseen that, when all main pipelines are completed, it will be relatively easy to add to the system in such a way as to provide a link from the Mediterranean to the North Sea, by running a comparatively short pipeline from Strasbourg or Karlsruhe to Cologne and, perhaps, another short link to Switzerland, to ensure that if, for any reason, supplies entering Europe from either the north or south were cut off, the crude oil could enter from the other end of the network and so maintain the necessary supplies for the defense of the West.

Four Major Pipelines

There are four major pipelines completed or in various stages of construction aimed at feeding the needs of West Germany, and at the same time parts of France, Holland, Belgium, and Luxemburg. These include the completed Wilhelmshaven to Cologne pipeline, which can now carry 9,000,000 tons of crude oil yearly from the North Sea port to a range of refineries 245 miles away in the vicinity of Cologne.

The operating company is a consortium of the leading international companies in Europe and the pipeline has been designed eventually to deliver at least 20,000,000 tons of crude a year to their various refineries.

Another pipeline to the Cologne area started delivering crude to other refineries in the Cologne area in the spring of this year. This line starts at the Dutch port of Rotterdam and is initially capable of carrying 7,500,000 tons a year, but its capacity later will be increased to 15,000,000 tons annually. The largest single shareholder in the operating company of this pipeline is the Royal Dutch/Shell group.

There are two other projects to carry oil to West Germany. The more advanced of these is to transport crude oil from Lavera, near Marseilles, over a distance of 470 miles to refineries near Strasbourg, and across the German frontier to Karlsruhe. Sixteen oil companies are involved in the project, which has the present completion date of the end of 1962. Initial carrying capacity of this line is put at 10,000,000 tons of crude a year to four refineries, and later to be increased to more than 30,000,000 tons.

At a less advanced stage, and still the subject of considerable controversy, is a plan financed by Italian interests with additional money from Switzerland and West Germany, for building a pipeline from Genoa, Italy to Aigle, Switzerland, and thence to Munich. The Italian national oil corporation, ENI-AGIP, is behind this proposal and there is little doubt that the pipeline will be constructed from the port of Genoa to Aigle. But the controversy over its extension into West Germany, at Munich, still makes that section of the pipeline a matter of doubt.

A shallow river in southern France is crossed by bridging.

The reason for the dispute is a tussle for superiority between the major international petroleum interests and the Italian national one. The basic plan for the pipeline provides for it to run from the port installations in Genoa, through the St. Bernard tunnel, now being built, to Aigle. There refining capacity would be provided by Swiss associates of the Italian company. The disputed extension would take crude oil on to Munich, from which city distribution of refined gasoline and fuel oil would be made to southern Germany, an area in which the Italian national oil company has not hitherto been active.

Early this year, two of West Germany's largest oil companies announced that each had decided to build an oil refinery in Bavaria, near Munich. These companies were the Esso AG and Shell AG. The Aral and the German BP (British Petroleum) companies also said they were considering building new refineries in the same area.

None of these companies favors the idea of using the Genoa-Aigle pipeline and they are proposing to build one of their own as a cooperative effort to feed the new Munich-district refineries. Two plans are now under consideration: One is to extend the Marseilles-Karlsruhe pipeline to Munich, and the other is to build one as part of a plan for a double-decker autostrada from Venice across the Alps to the Bavarian capital.

Key: Interior Refineries

The immediate reason for this striking change in the pattern of oil distribution within Europe is the rapid expansion of refineries in the interior of the continent. Before World War II and immediately after it ended, refineries usually were built near the sources of oil and only the refined product was brought to Europe. For a number of reasons, political and economic, in the past ten years or so the tendency has been to bring the crude oil to Europe and build the refineries for it nearer to the consumer markets.

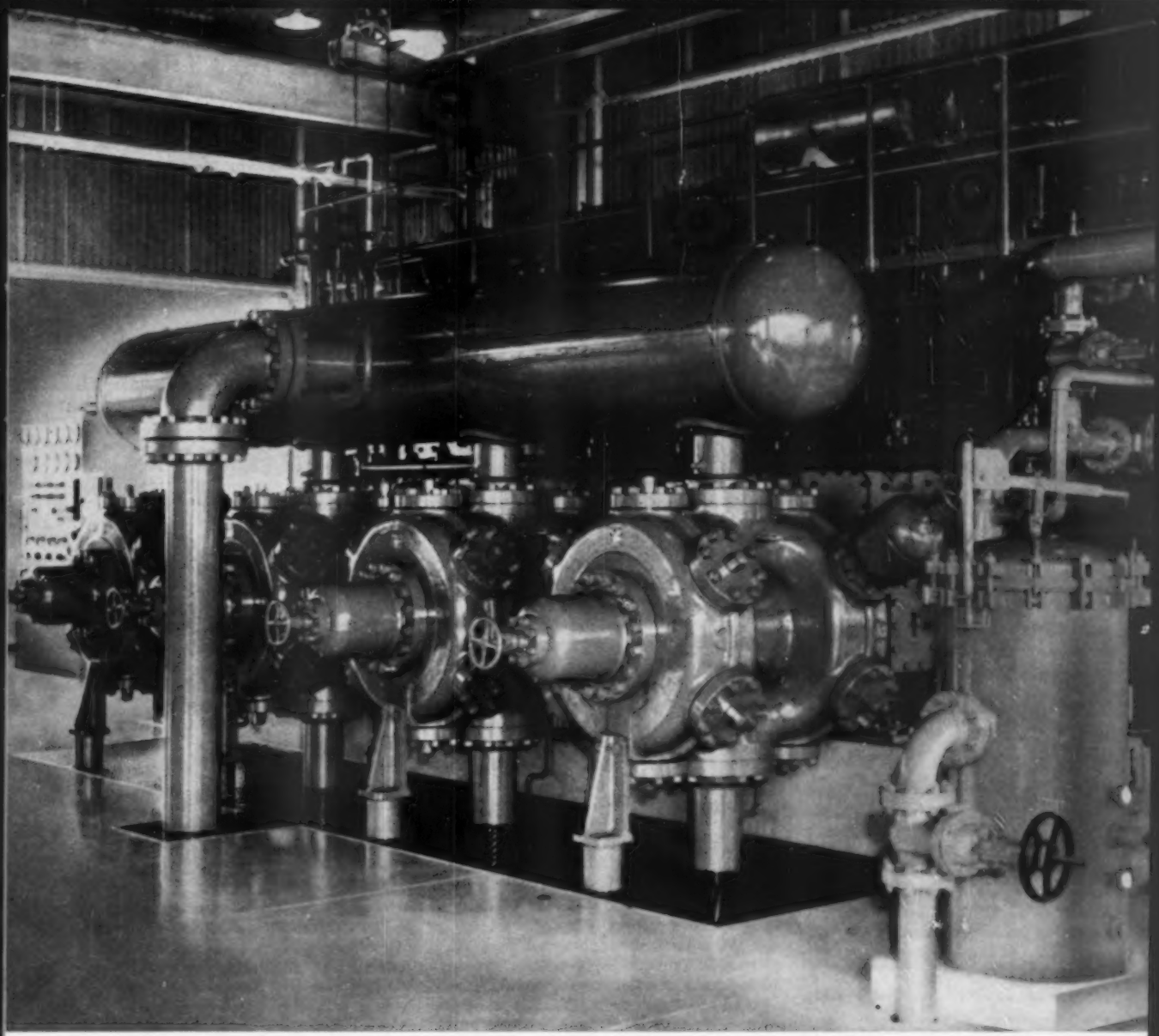
Now a second stage in this trend is appearing and refineries are being taken even nearer to their markets in Central Europe. Possibly a movement of this kind would have manifested itself earlier if West Germany had made a faster recovery immediately after 1945, for one of the main reasons for the present expansion plans is the tremendous growth of the German market for oil products.

Rise in Fuel Oil Demand

As in most European markets, the major element in this growth is the rise in industry's requirements for fuel oil. Ten years ago, West Germany needed no more than 200,000 tons of fuel oil a year; by the end of 1960 the annual rate of consumption is expected to be 12,500,000 tons.

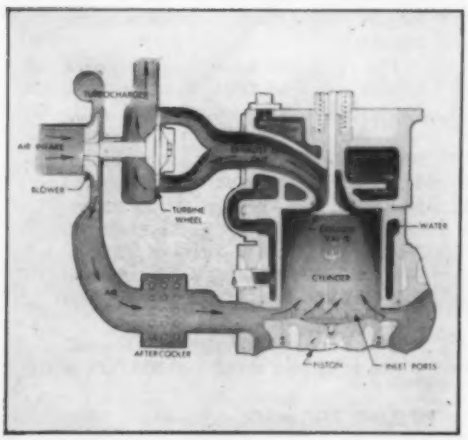
To satisfy this greatly increased demand — and for petroleum products generally — new refineries are being built that will double the country's refining capacity to some 30,000,000 tons within the next few years.

This is not a trend that is peculiar to West Germany. Throughout Western Europe the use of oil, and particularly of fuel oil, is rapidly increasing, and the new pipelines will serve additional refineries in France, Italy, and Switzerland.



At Northern Natural's Clifton Station, this SUTC engine compressor operates

20 HOURS A DAY...FOR 3 STRAIGHT YEARS



Self-sustained turbocharging at any speed and load is possible because of SUTC's exclusive Uniflo scavenging.

Five years ago a remarkable new engine compressor was introduced.

Called the SUTC, this Worthington turbocharged 2-cycle engine compressor was unlike any other. Combustion air enters thru side inlet ports, *but the exhaust is thru overhead valves*. Valve timing can be arranged to give maximum supercharging effect.

On paper, straight-thru or "Uniflo" scavenging has many advantages. The turbocharger operates over the entire speed and load range without help from external sources. Scavenging efficiency is increased and pulsations practically eliminated.

Now came the real test. More than 130,000 hp were installed. Operators praised the SUTC's exceptionally smooth, quiet operation. Operational records confirm the machines reliability. Unit G-2312 is typical. This 8 cylinder, 2000 hp SUTC engine compressor was installed in 1957 in Northern Natural Gas Company's Clifton, Kansas Station. To date, it has logged over 20,000 hours—an average of more than 20 hours a day for 3 straight years. A sister unit installed last year has equalled this performance.

May we send you complete data on this unique engine compressor? Please write to H. C. Barten, Worthington Corporation, P.O. Box 953, Buffalo 5, N.Y.

WORTHINGTON

Pipeline Cost Cheapest

At present, the inland markets of Germany are supplied with refined products delivered mainly by river barges, which are a familiar sight in the Rhineland. But a distribution system of this kind has serious economic disadvantages. In the first place, it is a relatively expensive way of transporting crude oil, for, to take some figures given at the World Petroleum Congress in New York last year, it will cost about 60 cents to transport 100 tons of crude oil each mile through a pipeline from the North Sea (at Rotterdam or Wilhelmshaven) or the Mediterranean (at Marseilles or Genoa) to refineries at Strasbourg, and probably less when the pipelines are fully operative. By contrast, the cost of river transport along the Rhine is about 95 cents per 100 tons per mile.

It would be even more expensive to transport the crude by rail or road — between $2 and $4 per 100 ton/miles by rail tank-cars for example. For these reasons, it is clearly much more economical to move the crude oil by pipeline to refineries.

The question is often asked, why not refine the crude oil at the ports where the tankers arrive and deliver the refined products through pipelines to the various markets? To support this the case is cited of the North Atlantic Treaty Organization, which already has a long network of pipelines to carry aviation gasoline and jet fuel to bases throughout Western Europe. But a system of the NATO nature is not suitable for the distribution of the much wider range of petroleum products demanded by industrial and domestic users.

It is an accepted rule that considerable economic advantages are to be gained by using larger pipelines. The cost per barrel is almost halved if the amount of oil that can be transported is increased fourfold, to take one example. This means that there is a premium on carrying crude oil, as it is normally delivered through larger pipelines than the refined products. There is also another problem, that a distribution system of this kind is less suitable for the transport of fuel oil, Europe's greatest need.

Arguments of this kind have been decisive in company plans for the locating refineries in inland Europe and the construction of pipelines to take the crude oil to them. But there is also another reason for the development of pipelines from the Mediterranean into the heart of the European continent. At present, the principal source of Europe's oil supplies is the Middle East. West Germany, for example, gets fully four-fifths of its oil imports from the Middle East.

African Supply Limited

Even now that Saharan crude oil is flowing through the first pipeline to the Mediterranean, it is likely to be several years before North African supplies (Saharan and Libyan) will be available in sufficient quantities to meet the needs of France, let alone those of other parts of Europe. Even when it does, crude oil from both areas will still have to cross the Mediterranean and Marseilles and Genoa will still be the natural ports of entry. The question of an undersea crude oil pipeline is not being considered, as the minimum distance between North Africa and France is 500 miles and the Mediterranean is extremely deep in parts.

This is clearly the justification for the pipeline from Lavera, near Marseilles, to Strasbourg and Karlsruhe, which the French Government is anxious to see completed as soon as possible, and for the proposed pipeline northward from Genoa to Aigle.

As mentioned, there is an alternative plan to transport crude oil from Venice into West Germany at Munich, which is favored by some of the leading international oil companies serving West Germany. They are supporting a plan to build a pipeline in conjunction with a revolutionary type highway. The autostrada would have two "stories," one above the other, and would thus require only half the usual width of land. The oil companies propose to run their pipeline alongside the highway, either on the upper or lower level.

Whether this proposal will come to fruition remains to be seen. It would require a large amount of money from the Italian state, and no bill has yet been presented to Parliament for the purpose. In Germany, the Bavarian Land Government would have to give authority and probably provide finance. It may well be, however, that the international oil companies will prefer to pay a big part of the bill themselves rather than have to play second fiddle to the French authorities or the Italian national oil company, as they would have to do if they used either the Marseilles or Genoa pipelines.

Sea Crossing Nearer?

Pipeline construction in Western Europe is not confined to the movement of crude or refined petroleum. The middle of September it was announced that French engineers had satisfied themselves that they had solved the technical problems connected with laying a natural gas pipeline on the Mediterranean seabed to bring Saharan gas to European markets. The French regard a pipeline from Mostaganem, in Algeria between Algiers and Oran, to Cartagena, in southeast Spain, as the best means of transporting natural gas from Hassi R'Mel. This pipeline could be joined to the network of natural gas pipelines already radiating across France from the other great natural gas sources at Lacq, near the Spanish frontier.

The pipeline will be nearly 500 miles long and 8⅔ in. in diam. About 100 miles of it will be laid under the Mediterranean. Its greatest depth will be just under 9000 ft—the chief difficulty that has had to be tackled in the preliminary studies.

About two-thirds of the 315 mile pipeline linking Hassi R'Mel to the coast is reported to have been laid, and by March, 1961, supplies of natural gas are expected to reach Algiers and Oran by means of an east-west pipeline on which good progress is also being made.

Algeria itself will not be able to absorb more than a small part of Sahara gas. A new company, called Semarel, has been set up to market the gas in Europe; the participants are the French state, Gaz de France, and the two oil companies who control the Hassi R'Mel field—Repal and CFP (Algeria).

Plans for Britain

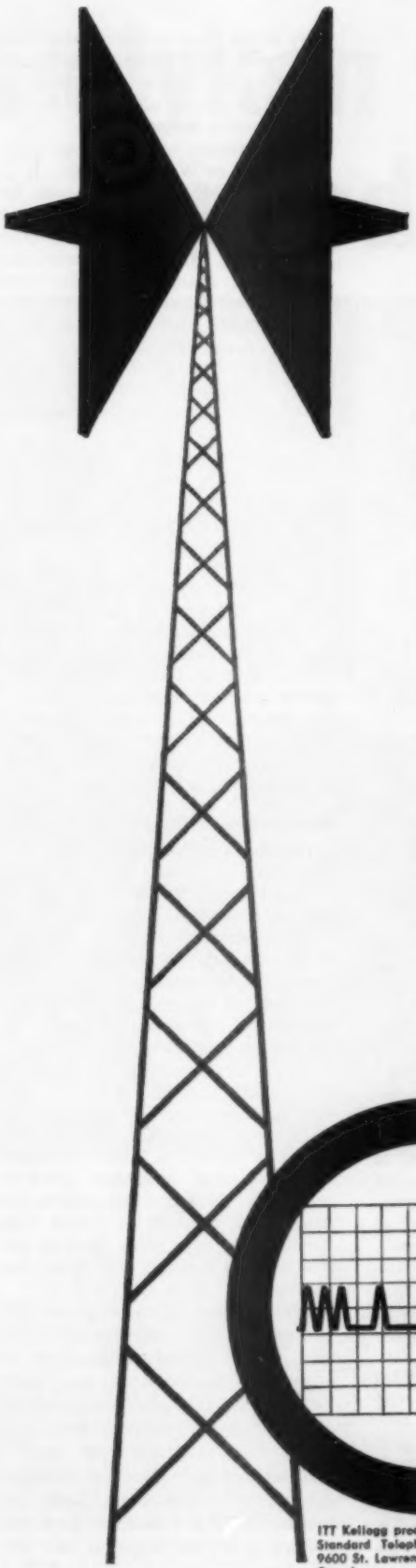
Standing geographically apart from the continent of Europe, Britain is building its own network of pipelines to link the various new tanker ports and coastal refineries with London and other big city centers.

The Shell Mex-B.P. organization are to build one from the Thames estuary to Hertfordshire, about 20 miles north of London. This will link the existing refineries at Shellhaven and Coryton with an area that is rapidly becoming heavily industrialized. When this plan is developed, it will eventually link with another pipeline from the same refineries to London Airport.

A more ambitious project—a 100-mile pipeline from near London to storage installation in Birmingham in the heart of England's industrial Midlands — is contemplated by the Esso Petroleum Company. It will be the longest private company pipeline in the country.

The same company has proposed a 75-mile pipeline from its refinery at Fawley, near Southampton, to a point near the London Airport. Legislation for this project—estimated to cost some $7,000,000 already has been presented to Parliament. The cost of this undertaking includes the storage depot, which will have a capacity of 20,000,000 gal. It is hoped that work can begin this year and be completed by the end of 1963.

The London-Birmingham proposal, which is to cost about $10,000,000, is



here's microwave at its simplest and best!

KELLOGG 10C2 PTM MICROWAVE

Pulse Time Modulation is the foolproof microwave pioneered and developed by International Telephone and Telegraph Corporation. No other system can compare with it in simplicity and reliability. Installations around the world (some dating back to ITT's early systems in the '30's) prove the soundness and reliability of PTM.

- ☐ **ONLY PTM** eliminates complicated tuning or filtering for voice channel separation. All demodulators are interchangeable.
- ☐ **ONLY PTM** provides separate and distinct channels, open only during its own time interval. Therefore S/N is not a function of channel loading; each channel is insensitive to modulation on the other channels.
- ☐ **ONLY PTM** eliminates frequency displacement over the voice channels.
- ☐ **ONLY PTM** permits *any number* of channels to be dropped at a repeater station. Only one additional modulator and one plug-in demodulator are required to drop each channel.

The Multiplex end of Kellogg 10C2 Microwave system can combine up to 45 separate voice frequency channels into a Time-Modulated Pulse train, and provides the means for restoring each of the channels into its original audio signal. Each signal is sorted into its proper channel at the receiving end by means of the distinctive marker pulse it carries.

Kellogg 10C2 Multiplex features the latest and most efficient engineering advances: modular construction, printed circuitry, plug-in channel units, interchangeable modulators and demodulators, and many others. You'll find Kellogg PTM Microwave meets your highest specifications for performance, reliability and engineering design.

Complete technical details will be sent on request. Write to Kellogg's Microwave Division, Box 2725, Raleigh, North Carolina.

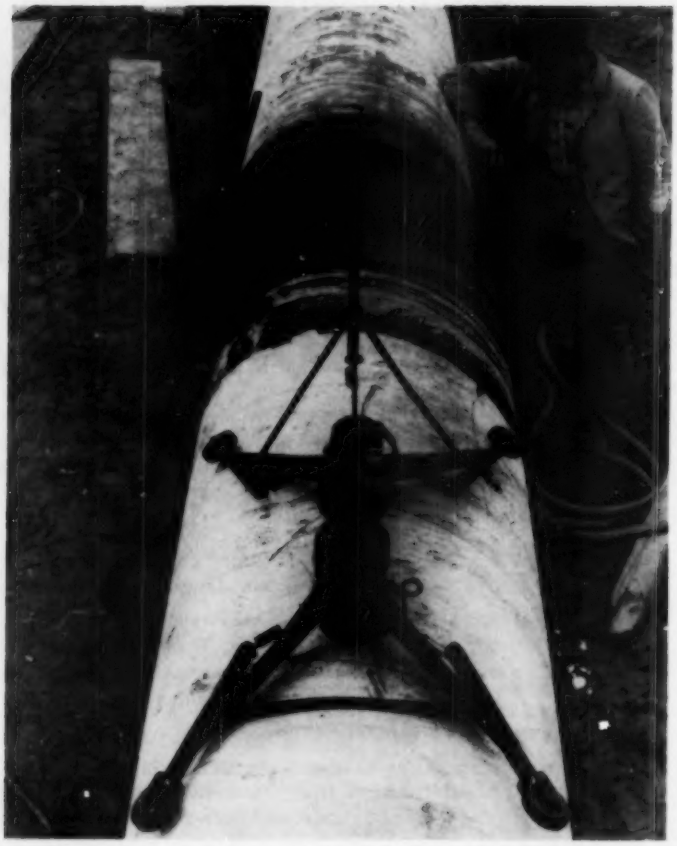
ITT KELLOGG

A Division of International Telephone & Telegraph Corporation, 6650 South Cicero Avenue, Chicago 38, Ill.

Telephone and Transmission Dept., 2912 Wake Forest Road, Raleigh, N. C.

Regional Offices and Warehouses: CALIFORNIA: 23 Broderick Road, Burlingame, California, OXford 7-5780 • **GEORGIA:** 1594 Southland Circle, N. W., Atlanta 18, Ga., SYcamore 4-2441 • **ILLINOIS:** 4600 So. Tripp Ave., Chicago 32, Illinois, CLiffside 4-4300 • **KANSAS:** 7th and Sunshine Road, Kansas City 15, Kansas, MAfair 1-4418 • **NEW YORK:** 327 North West Street, Syracuse, N. Y., HArrison 2-9251 • **TEXAS:** 1359 Motor St., Dallas 7, Texas, Riverside 7-5191 • **HAWAII:** 178 Kalaheo, Kailua, Oahu, Hawaii, 268242 • **EXPORT:** 4600 So. Tripp Ave., Chicago 32, Illinois, CLiffside 4-4300.

ITT Kellogg products available in Canada through Standard Telephones & Cables Mfg. Co., Ltd., 9600 St. Lawrence Boulevard, Montreal 12, P. Q., Canada.



A section of the Wilhelmshaven to Cologne pipeline is checked by radiography.

regarded by the company's experts as a logical extension of the pipeline from Southampton. The geographical position of Birmingham, almost exactly 100 miles from any port to which tanker-borne supplies can be taken, makes the city and the big population area surrounding it an ideal point for a pipeline terminal.

Another Esso pipeline soon to be built is a 70-mile one to carry ethylene from its refinery at Fawley, near Southampton, to the new plant of Imperial Chemical Industries on the banks of the River Severn. The estimated cost is $2,250,000. This pipeline will be the first of its kind in Britain to link a refinery and a large chemical plant. It will be at least 30 in. underground and will cross railroads, highways, rivers, and canals. Construction is expected to start by the end of the year. Work on the new ICI plant, the first stage of construction on a 1000-acre site, already has started and will cost about $14,000,000.

Two 23-mile Shell-Mex pipeline from Stanlow, on the Mersey, to Manchester have just been put in operation.

War-time Pipelines Eyed

Also under consideration by some oil companies is the extent to which they could lease war-time emergency pipelines owned by the government. Some 1200 miles of these pipelines were built to take supplies from west coast ports to bomber and fighter bases in southern and eastern England. When they were in full use they were carrying nearly 5,000,000 tons of gasoline a year. The extent of the use of this network, even now, is secret under government security measures. But, apart from supplies still being pumped to Royal Air Force stations, a portion of the pipelines has been let to private companies. Discussions are taking place about taking up the unused sections.

Russia's Plans

Because Western Europe is making such tremendous strides with its international pipeline network, the Russians have had to come up with a plan of their own to maintain "face" with their satellites. A vast Soviet plan provides for the construction of a 2500 miles trunk pipeline to carry the crude oil from fields along the Volga and around the Caspian Sea to East Germany, Poland, Hungary, and Czechoslovakia. It is also seen as the spearhead of an intense Soviet oil export drive to the West, following the political turmoil the Russians already have stirred up or are in the process of creating, in several of the Middle East oil production centers.

Russia already is selling large quantities of oil in Western Europe. It already has negotiated agreements for sales to West Germany, Austria, France, Denmark, and Norway, often underbidding Western oil companies. France, for example, will buy more than 2,000,000 tons of Russian oil in 1960 — more than twice last year's amount. Russia has tremendous oil resources, whereas her own domestic use is still fantastically small, since private autos exist there only in negligible numbers.

Apart from bringing Soviet oil 2500 miles nearer to Western Europe, Russia will derive two other major advantages from the pipeline. It will form the sinews of Khrushchev's "grand design" for Eastern Europe—to make the area a giant, fully integrated economic unit that will serve as the basis for a future communist federation of East Europe. The pipeline will complement the other East European project, a power electricity grid linking all satellites. The second advantage will be that the pipeline will have tremendous strategic value as a convenient oil tap for Russian forces in East Europe.

Remember "Pluto?"

Details reveal the pipeline will cross the rivers Volga and Dnieper, curve over to Minsk in Byelorussia. At Minsk the line will divide, one branch going north to Poland and East Germany, the other south to Czechoslovakia and Hungary. All satellite countries will take part in the project, but Russian technicians and engineers alone will control the operation.

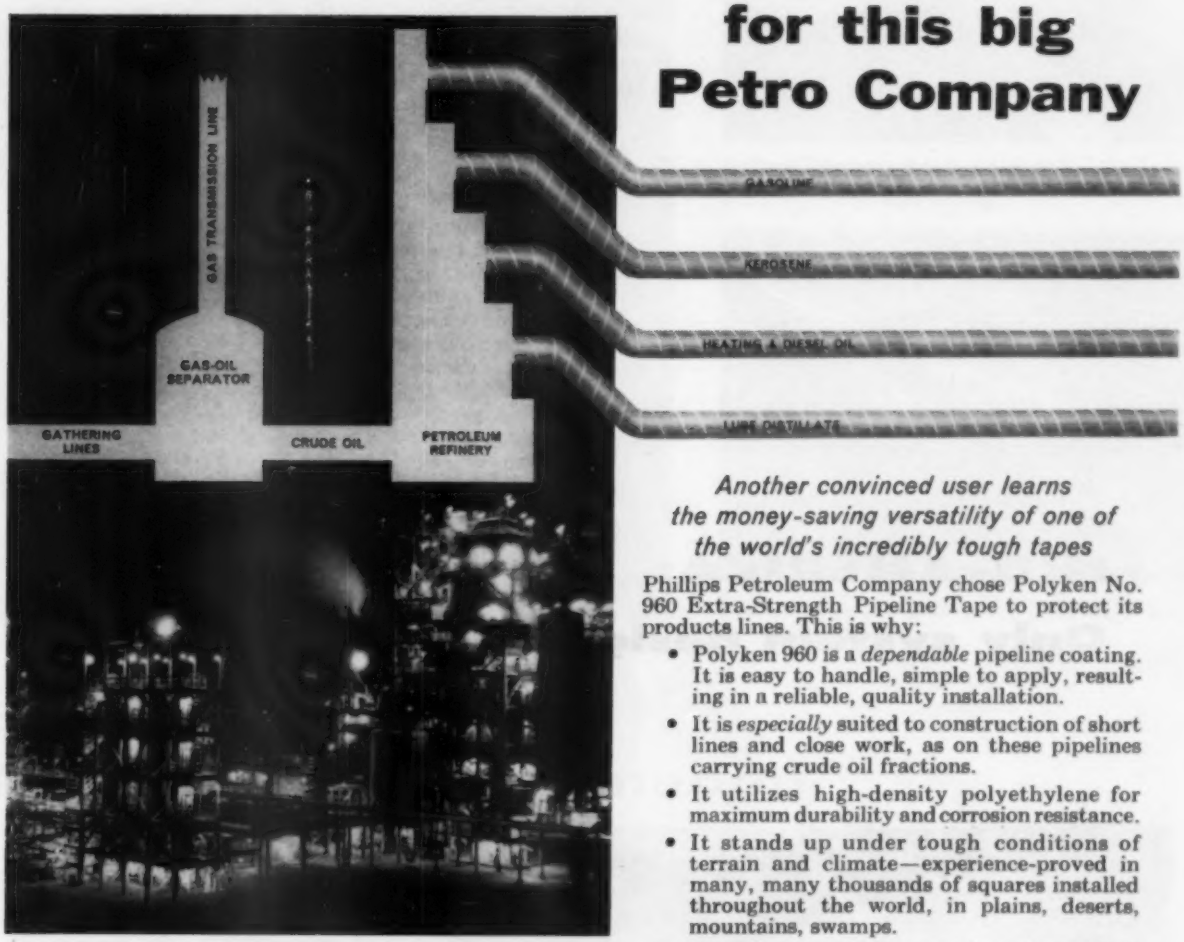
As yet, there is no plan to reconstruct the pipeline that played such a vital part in the invasion and reconquest of Europe in 1944-45. "Pluto" — the "Pipeline Under the Ocean" — helped feed the vital petroleum products needed by Allied armored vehicles and trucks and by their air forces from Britain, first into France, then on into Belgium and Holland, and finally into Germany.

Whether such a cross-channel link will ever be built again remains to be seen. It was proved possible from an engineering point of view, even under the most adverse conditions, but the economics did not matter in those days.

But, with or without a new Pluto, a vast network of oil and gas pipelines is being built to criss-cross Europe and helping to bring a more international outlook to all the countries they link together. ★ ★ ★

Polyken tape protects products lines

for this big Petro Company



Another convinced user learns the money-saving versatility of one of the world's incredibly tough tapes

Phillips Petroleum Company chose Polyken No. 960 Extra-Strength Pipeline Tape to protect its products lines. This is why:

- Polyken 960 is a *dependable* pipeline coating. It is easy to handle, simple to apply, resulting in a reliable, quality installation.
- It is *especially* suited to construction of short lines and close work, as on these pipelines carrying crude oil fractions.
- It utilizes high-density polyethylene for maximum durability and corrosion resistance.
- It stands up under tough conditions of terrain and climate—experience-proved in many, many thousands of squares installed throughout the world, in plains, deserts, mountains, swamps.
- Its cathodic protection requirements are low.

AND . . .

- It saves money: Polyken 960 goes on fast with less men per job, covers more miles per day. Less equipment, less handling costs. More savings over the old hot dope idea.

See your Polyken Man . . . call your Polyken Tape Coating Distributor . . . or write Polyken, 309 West Jackson Blvd., Chicago 6, Illinois.

©1960 The Kendall Company

Phillips pipe is cleaned and wrapped by Brodie Construction Company in a single factory-smooth operation. No primer, no drying or cooling. No fumes or fire hazards.

Polyken®

EXPERIENCED IN PROTECTIVE COATINGS

THE KENDALL COMPANY
Polyken Sales Division

MID-AMERICA:
Only system designed solely for LPG

FRANK H. LOVE, *Editor*

The 2160-mile pipeline from Permian Basin area into Wisconsin and Minnesota expected to give big boost to use of liquefied petroleum gas

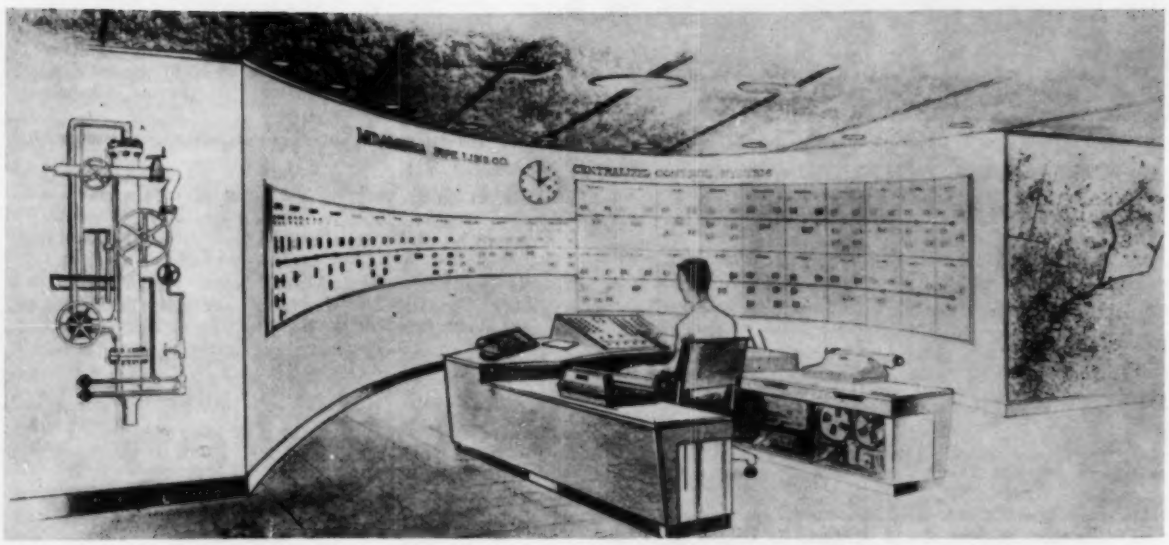
MID-AMERICA Pipeline, soon to be completed, will be an unusual system . . . it will be the only independent common carrier pipeline designed exclusively for movement of LPG — propane, butane, and natural gasoline.

Other systems have added these products after initial operations, but none has been designed solely for their transportation.

Mid-America is expected to give a big boost to LPG consumption. Not only will it provide a transportation facility for 60,000 bbl per day immediately upon completion, but in the words of its president, Robert E. Thomas, "When consumers learn that LPG is available without interruption the year 'round, this confidence will encourage more of them to equip their plants, homes, machinery, etc., for its use."

End uses for LPG in the area served are for cooking, water heating, refrigeration, clothes drying, space and central heating in homes and commercial establishments, fuel for tractors, trucks, fork-lift trucks, buses and other vehicles with internal-combustion engines, standby fuel for various commercial and industrial concerns, fuel in numerous industrial and agricultural applications, including use in stationary pumps and engines, boiler firing, flame torches for plumbing, paint removal and metal treatment, in poultry brooders, weed burners, as well as other uses where close control of temperature and localized application of heat are desired.

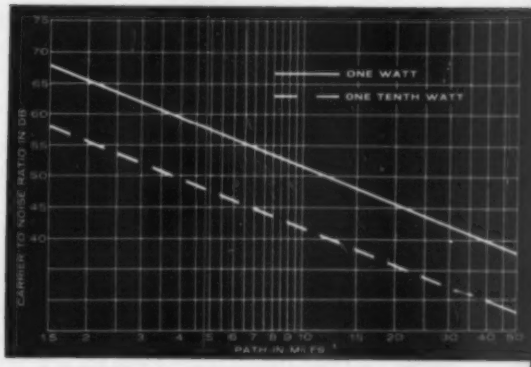
Additional utilization is foreseen by gas distribution companies for peak shaving, and for mixing with air in



System will be operated from Tulsa headquarters by means of this centralized control system.

New MCR-1000 Microwave System.

Raytheon communications engineers work as a team with data processing specialists to insure optimum systems design.



One watt output of MCR-1000 offers improved carrier-to-noise ratio.

Raytheon Microwave Means Reliable Automation

Because Raytheon communications and data handling are an integrated, under-one-roof activity, Raytheon engineers take a "whole system" approach to pipeline microwave and automation systems.

Raytheon is the first company to bring together these highly specialized engineers and scientists in one operation. The result is *depth* of capability in communications-data handling systems.

Raytheon engineers will plan and install automation systems that fit your particular operation exactly, assuring optimum performance and reliability, minimum maintenance.

Illustrated above is Raytheon's MCR-1000, a new one-watt output, 240-channel microwave communications system featuring in-socket tube testing, advanced switchover design and supervisory control.

The world's largest company devoted exclusively to electronics, Raytheon offers complete, no-obligation engineering service in planning and integrating your microwave-data handling system.

RAYTHEON EQUIPMENT DIVISION

EXCELLENCE IN ELECTRONICS

Send Coupon Today For Brochures

DIRECTOR OF MARKETING,
Equipment Division,
Department H-1, Raytheon Company,
West Newton, Massachusetts

Please mail me literature on:

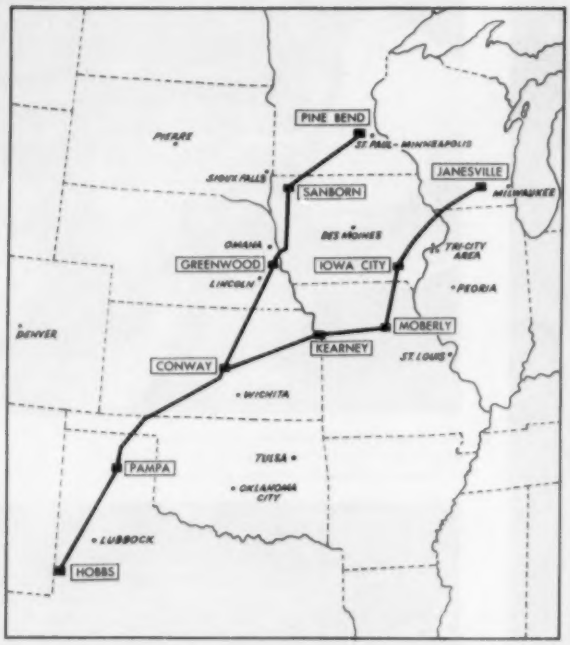
☐ MCR-1000 ☐ Microwave Path Survey Manual

*Name and Title*_____

*Company*_____

*Address*_____

*City and State*_____



Mid-America Pipeline system. Names in squares are operating terminal stations.

central plants in smaller towns for distribution to home consumers.

First incorporated under Delaware law as Midcontinent Eastern Pipeline Corporation, October 3, 1958, the present name of Mid-America Pipeline Company was adopted January 29, 1960. Headquarters are in the new Skelly Building at 1437 South Boulder, Tulsa, Oklahoma.

The system, which includes 2160 miles of pipe from 4 to 10 in. in diameter — 1684 miles of trunk line and 476 miles of gathering lines — is connected to more than 30 natural gasoline plants in the West Texas, southeastern New Mexico, Oklahoma Panhandle area. The main trunk line originates near Hobbs, New Mexico, and extends north to Conway, Kansas, which is a few miles west of McPherson. Here it divides, the West Leg passing Lincoln and Omaha, Nebraska, and Sioux City, Iowa, terminating near St. Paul, Minnesota. The East Leg passes near Kansas City and Moberly, Missouri, then turns northward to pass Ottumwa, Iowa City, and Dubuque, Iowa, terminating in Janesville, Wisconsin. Along the route there are seven delivery terminals.

Initially, the line will have capacity to deliver 50,000 bbl per day to Conway, and, supplemented by product from underground storage, move approximately 60,000 bbl a day to various delivery points on the West and East Legs.

Design of the system is such that by adding pumping facilities capacity of the trunk line into Conway Terminal can be increased to 83,000 bbl a day, and to about 86,000 bbl a day out of that point.

Deliveries into Conway will consist of propane, butane, and natural gasoline, but beyond that point initial shipments will be principally propane. The natural gasoline and butane will be delivered to refiners in the McPherson area. Full operation of the system is scheduled for December 1.

The Pipeline

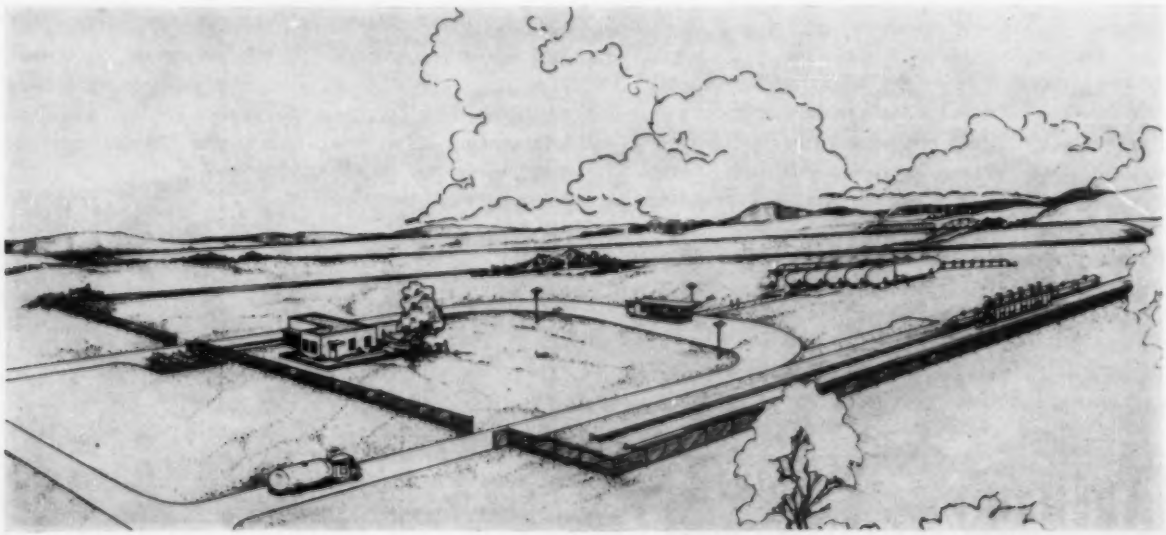
The Permian Basin gathering system is composed of 476 miles of 4, 6, and 8-in. pipe. One 300-hp pumping station is being installed on the gathering system. Pumps at plant origin points deliver to the line.

The line between Eunice, New Mexico, and Pampa, Texas — 226 miles of 8-in. — has three pump stations of 1300 hp each, and a capacity of 35,000 bbl a day.

Between Pampa and Conway, Kansas, the 288 miles was constructed of 10-in. pipe. This section also has three stations, but the horsepower of each is reduced to 1200. This section can carry 50,000 bbl per day.

At Conway where the line divides there are two stations of 1000-hp each. As the stream is split at this point, the size of the lines is reduced to 8-in., and 30,000 bbl per day sent through the West Leg, which terminates in Minnesota, and 30,000 bbl through the East Leg, which terminates in Wisconsin.

The 198-mile section from Conway Terminal to Greenwood, Nebraska, has two pump stations of 1000-hp each. On the Greenwood, Nebraska-Sheldon, Iowa, 177-mile section there is one 600-hp station. To boost product 165 miles from Sheldon to Pine Bend Terminal, near St. Paul, there is a single 200-hp station.



Artist's drawing of a typical Mid-America distribution terminal.

Rippers were used ahead of trenchers to locate rock, remove the smaller ones, and break tree roots.

Drilling shot holes where rock had to be blasted.

On the East Leg, the 180-mile section between Conway and Kearney, Missouri, has two 900-hp stations; the 300-mile Kansas City-Iowa City, Iowa, section one 600-hp station, and the 152-mile Iowa City-Janesville, Wisconsin (near Madison) section one 600-hp station. Between Iowa City and Janesville the size of the line is reduced to 6 in.

This represents a total of 15 pump stations and 13,600 hp.

Pumping units are all motor-driven centrifugal pumps, the pumps being equipped with mechanical seals.

Company-owned operating terminals are being constructed at Hobbs and Conway. Company-owned delivery terminals are at Greenwood, Nebraska; Sanborn, Iowa; Pine Bend, Minnesota; Kearney and Moberly, Missouri; Iowa City, Iowa; and Janesville, Wisconsin.

Shippers may construct their own delivery terminals at the above destinations if they so desire, providing certain storage requirements are met.

Each of the terminals has aboveground storage tanks, metering equipment, tank truck and rail tank car loading racks. An exception is at Moberly where only trucks will be loaded.

The high pressure at which the Mid-America system must be operated in order to keep the LPG in liquid form, necessitated a special type gasket be used on all flange connections to prevent leaks or blowouts and their resulting hazard. The flange seals adopted consist of a rubber ring completely confined in a metal container, and originally were developed for the missile and aircraft industries. Prior to their selection they were subjected to a pressure test exceeding 4000 psi.

Hobbs A Key Point

Hobbs, New Mexico, is a key point on the system and the originating point for the main trunk line. Three pipelines converge at this point. Two underground storage caverns are being provided here, each with a capacity of 150,000 bbl, as well as six 1500-bbl each horizontal propane pressure storage tanks. These facilities and two pumping units that boost 35,000 bbl of product per day toward Pampa are all controlled from the Hobbs station, and a well-designed 10-in. manifold is an essential part of the setup. Dehydration facilities are located at Hobbs.

This will be an attended station with one man per shift 24 hours a day, 7 days a week. In addition to station attendants, the gaging foreman for the Hobbs District will be stationed at this point, and, of course, there will be a station foreman.

Conway Terminal

Another key point is the Conway Terminal, where the system divides. Here three company-owned underground caverns are being dissolved from a salt formation, and six 1500-bbl propane tanks are being erected. To supplement Mid-America's own storage, the area has five underground storage facilities owned by other companies. Two are in the immediate Conway area, and three near Hutchinson only a short distance away.

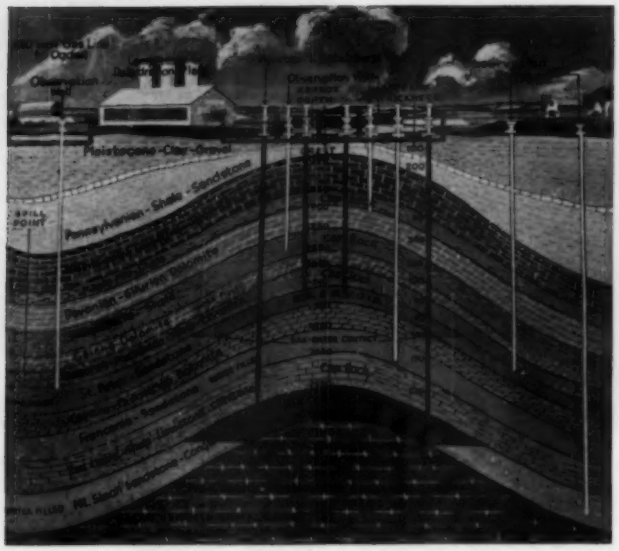
Two pump stations, one for each leg of the system, a 10-in. switching manifold, and dehydrating equipment complete the principal installations, all of which will be controlled from the Conway terminal. This also will be an attended terminal with one man per shift.

Terminals on both the southern and northern parts of the system, except Pine Bend and Janesville, will have two truck loading docks and two loading pumps capable of

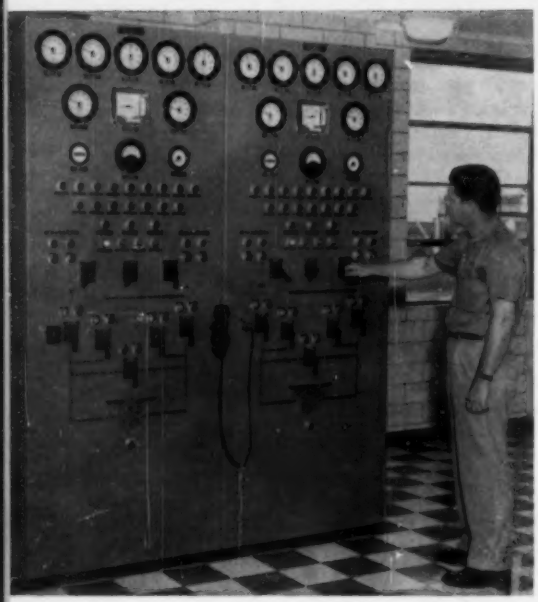
TABLE 1. Pipe Mileages and Sizes, Station Ratings, Line Capacities.

Section	Miles	Diam., in.	Hp each station	Number stations	Capacity, bbl/day
Gathering systems	479	4, 6, 8	300	1	Varying
Delivery spurs	12	6-10	—	—	Varying
Eunice-Conway line:					
Eunice, New Mexico-Pampa, Texas	233	8	1300	3	35,000
Pampa-Conway, Kans.	286	10	1200	3	50,000
Minnesota line:					
Conway-Greenwood, Nebr.	198	8	1000	2	30,000
Greenwood-Sheldon, Iowa	177	8	600	1	30,000
Sheldon-Pine Bend, Minn.	165	8	200	1	30,000
Wisconsin line:					
Conway-Kearney, Mo.	180	8	900	2	30,000
Kearney, Mo. to Iowa City, Iowa	300	8	600	1	30,000
Iowa City to Janesville, Wisc.	152	6	600	1	30,000

Stations are located at Midkiff, Texas; Seminole, Texas; Levelland, Texas; Tulia, Texas; Pampa, Texas; Beaver, Oklahoma; Wellsford, Kansas; Conway, Kansas (2); Linn, Kansas; Eskridge, Kansas; Kearney, Missouri; Greenwood, Nebraska; Sanborn, Iowa; and Iowa City, Iowa.



▲ Cutaway drawing of underground storage reservoir at Redfield. This station injects into St. Peter and Mt. Simon sandstone at 59 wells. Ultimate capacity of both strata is about 140 billion cu. ft.



M. H. Raven (right), Superintendent of ▶ Northern Natural Gas Company's underground storage compressor station near Redfield, Iowa, until his recent promotion, discusses the facts with H. E. Hansen, Shift Engineer. Compressor in foreground is GMWA-8, rated 2000 hp. Another similar unit is in the background.

◀ Cooper-Bessemer En-Tronic control provides complete start-stop, loading–unloading automation for the engine driven compressor.

How a rugged compressor aids a variable-load gas storage program

During its first year's operation, Redfield Station of Northern Natural Gas Company has been put through a rigorous test. According to M. H. Raven, Superintendent, "Our Cooper-Bessemer GMWA-8 Compressor and En-Tronic Control have responded round-the-clock to this program of normal loading, underloading and overloading with remarkable performance. Despite abnormal loading, oil consumption and water usage have been very low. Inspection and cleaning after 12,000 hours showed all parts in perfect condition. It is a *rugged* machine!"

Call our nearest office for help in applying this kind of dependability and load flexibility to *your* compressor operations.

BRANCH OFFICES: Grove City • New York • Washington Gloucester • Pittsburgh • Detroit • Chicago • Minneapolis • St. Louis Kansas City • Tulsa • New Orleans • Shreveport • Houston Greggton • Dallas • Odessa • Pampa • Casper • Seattle San Francisco • Los Angeles • SUBSIDIARIES: Cooper-Bessemer of Canada, Ltd. . . . Edmonton • Calgary • Toronto • Halifax Stratford • C-B Southern, Inc. . . . Houston • Cooper-Bessemer International Corporation . . . New York • Caracas • Anaco • Cooper-Bessemer, S.A. . . . Chur, Switzerland • The Hague, Netherlands Mexico City • The Rotor Tool Company, Cleveland

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL, ENGINE, TURBINE OR MOTOR DRIVEN

Applying hot coal-tar enamel and wrapping.

loading 500 gal per min each. Pine Bend and Janesville each will have four truck docks and, of course, four loading pumps.

Positive displacement meters will be used for all custody transfer and will be calibrated with a piston pipe prover, about which more will be said later. At Hobbs, Conway, and each of the delivery terminals, turbine meters are being installed strictly for inter-company check.

Dehydration units, two at Conway Terminal and one at Hobbs, will use alumina H-151 as the drying agent. Each unit is capable of drying 1500 gal of product per min.

Storage capacities at delivery terminals are shown in Table 2.

Line Construction

Williams Brothers Company of Tulsa, Oklahoma, engineered, supervised, and constructed most of the line. McVean and Barlow of Odessa, Texas, subcontracted approximately 430 miles of the system, and some of the stations and delivery terminals were contracted to other companies.

Overall construction was somewhat routine, there being no serious problems of terrain or weather to hamper progress. Proof of these favorable factors is the speed with which the pipe has been put in the ground. On one day, for example, one spread made 32,000 ft. Another good record was 140,000 ft laid in one day by all spreads — four Williams Brothers and three McVean and Barlow.

Although right-of-way work began as early as April 6, no pipe had been shipped by that date, and it was not until April 25 that the first pipe was laid. Initially the prime contractor had two spreads in the field, adding another in June and still another in July. Main line spreads also have been responsible for installing river crossings, road, highway, and railroad crossings.

TABLE 2. Storage Capacities at Delivery Terminals.

Location	Storage capacity, bbl
Kearney, Missouri.....	3000
Moberly, Missouri.....	3000
Iowa City, Iowa.....	4500
Janesville, Wisconsin....	8000
Greenwood, Nebraska...	3000
Sanborn, Iowa.....	4500
Pine Bend, Minnesota...	8000

Terrain presented little difficulty, only a limited amount of rock being encountered. Practice has been to run a ripper ahead of the ditchers, which serves two purposes: To locate rock that requires shooting and break tree roots and make the work of the ditcher easier and faster.

Pipe was delivered in random lengths of 40 ft and up, and was entirely welded in the field. There was no double-jointing.

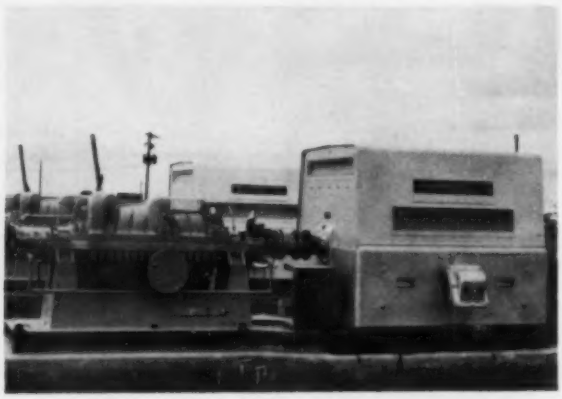
The protective program for most of the main line has been to coat with coal-tar enamel to a thickness of 3/32-in. and wrap with coal-tar impregnated glass. On river crossings this was doubled. In the case of gathering lines, and about 70 miles of main line north of Hobbs, the pipe was wrapped with polyethylene tape.

The eight major river crossings vary in width from 1500 to 12,000 ft. Installed by the main line spreads, as mentioned, these have, or will, all be pulled or pushed into place, except for one instance in which the pipe will be carried on a county bridge.

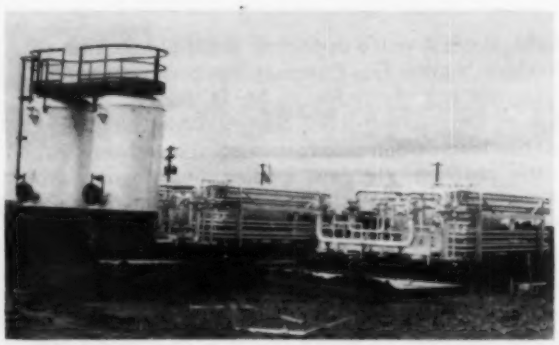
These are the river crossings and their widths:

North Canadian, Texas Panhandle — 8200 ft
Cimarron, Texas Panhandle — 1800 ft
Arkansas, north of Hutchinson, Kansas — 1500 ft
Platte, south of Lincoln, Nebraska — 12,000 ft
Missouri, north of Leavenworth, Kansas — 5700 ft
Missouri, near Decatur, Nebraska
(crossed on Burt County bridge) — 4500 ft
Kansas, near Topeka, Kansas — 1800 ft
Mississippi, south of Dubuque, Iowa — 8000 ft

The main line was tested by sections in accordance with the ASME-API Code — 10% above operating pressure, which, in this instance will be 1440 psi.



These 7-stage centrifugal pumps driven by 600-hp motors have a rated capacity of 875 gal per min at suction pressure of 200 psi and discharge of 816 psi.



Dehydrator unit at Conway Terminal.

NO PLACE FOR SISSIES

MOTOROLA 2-WAY RADIO TAKES A BEATING...
because it's built to take it!

A 2-way radio is a precise, complex electronic instrument. But unless it is *rugged* too—unless it can shrug off jolts and vibration and come back for more—it just can't go to work in the oil fields.

Motorola engineers *design* a radio to take it. Extensive field tests *make sure* it's no sissy—Motorola literally beats the "bugs" out. Then a tough, rigid quality control setup *keeps* them out.

This kind of consistent leadership in research, development and engineering has led to a radio that will stand up to rough treatment and still deliver dependable service—day after day. You'll see *why* when you check with your local Motorola representative—he'll give you all the facts. Write:

MOTOROLA 2-WAY RADIO

Motorola Communications & Electronics, Inc., 4501 Augusta Blvd., Chicago 51, Illinois • A Subsidiary of Motorola Inc.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Centralized Control System

Main line operations will be controlled from a central dispatching office in Tulsa, the gathering system from a central point at Hobbs.

Communications channels will be leased from the Bell System. There will be one channel for teletype and another for supervisory controls.

An accompanying artist's drawing shows the centralized control system that is being installed on the Mid-America system at Tulsa. From his position in front of the console, a dispatcher will be able to monitor operating conditions at all points on the pipeline system, adjust rate of flow and pressures, and operate the pump stations and terminals. Stations can be started and shutdown in their entirety, or single engines within a station started and stopped.

Completely integrated control is designed into the equipment, which includes digital remote control, digital telemetering, sequence control, instrumentation, data handling, computation, data for accounting, and coordinated communications.

The curved panel in the background of the illustration is a schematic representation of the Mid-America system. The panel contains digital data readout instruments, which show at all times the suction and discharge pressures at each station. There is also a red alarm light at each pump station site on the map to indicate to the dispatcher when an upset condition prevails. When an upset condition occurs, the red light is lit and the name of the station and current operating information for the station appear on the console. This, of course, enables the dispatcher to initiate action to correct the situation.

The control center is linked to stations and terminals by means of leased wire, as mentioned, and coded signals—a different one for each control function — are initiated on the control board and travel over the circuit to the station or terminal. There the coded signals actuate relays that, in turn, carry out orders received from the board. Codes can be initiated by pushbuttons and/or selector switches from the central dispatching office, by a change of status in the field, or by a change of data in the field.

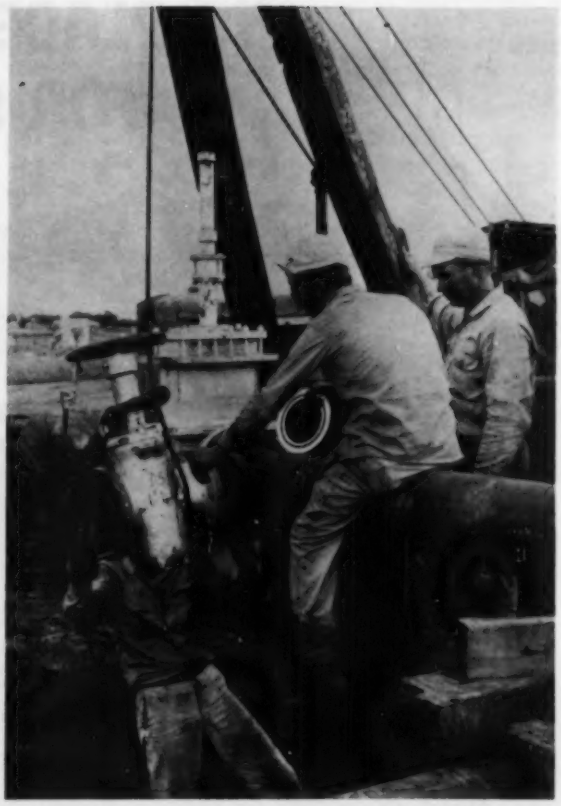
If two code units start to transmit at the same time a code preference is established, and transmission of the codes takes the following order: (1) Controls or data set point commands from the office; (2) lamp indications from the field, and (3) data quantities from the field.

One of the important factors in a centralized control system that handles a large volume of data from many remote locations is system discipline. Rigid discipline is necessary to prevent mutual interference, assure orderly handling of all information, and preclude loss of information. To assure this discipline the code system provides:

- Detection and rejection of codes distorted in transmission
- Predetermined, preferential assignments of codes initiated simultaneously
- Automatic and orderly handling of code information for transmission
- One station cannot hold the line if any other station has information to transmit
- A means of cancelling codes that have been placed in storage
- Automatic recall of incomplete indicating codes
- A means of recalling indication codes on demand
- A control code has preference over an indication code

Codes are given security by:

- Valid address selection detector
- Digit sum parity check
- Function selection by redundancy
- Correct pulse length check
- Function selection is non-composite
- Number of code steps are checked for total
- Short step length detection
- Step by step answer-back



Special type flange seals were installed to cope with high pressures.

Because stations are unattended for the most part, protection against abnormal operating conditions such as low oil pressure, overspeed, or high bearing temperature is provided by monitoring devices that automatically detect a dangerous condition, shut the engine down and prevent it from re-starting. Circuits provide similar protection during starting and stopping by opening and closing valves in the proper order and at the proper time.

The digital sequence equipment used to start and stop the pumping units is designed with emphasis on fail-safe components and circuitry.

If there is equipment failure anywhere on the system, protective devices will prevent damage to other parts of the pipeline system.

Contractors for construction of the stations and terminals are as follows:

Groniger and King, Pampa, Texas — Levelland, Tulia, Beaver, Wellsford, and Pampa.

Universal Engineers and Constructors, Tulsa, Oklahoma — Conway, McPherson, and Pine Bend.

Oil State Engineering, Tulsa — Hobbs and Seminole.

Station Pipeline and Construction Company, Oswego, Kansas — Eskridge and Kearney.

Uleston Industries, Tulsa — Moberly, Iowa City, and Janesville.

Meter Calibration

Because of the importance of accurate metering to the overall operation, the positive displacement meters will

Introducing

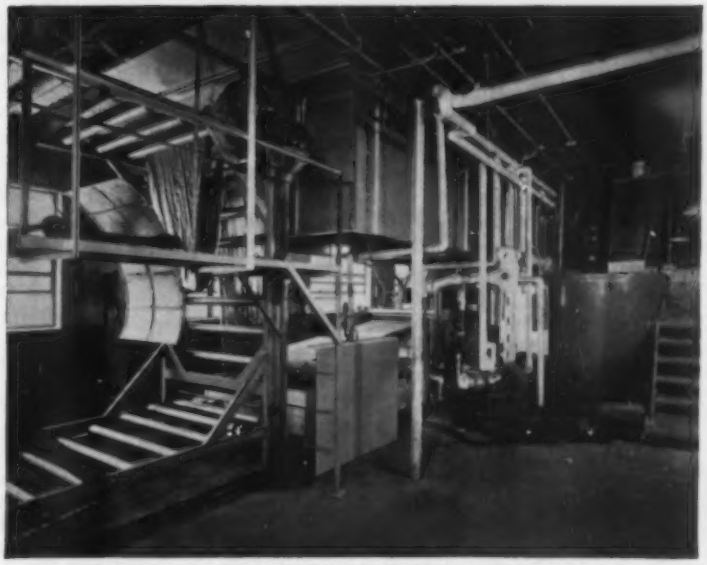
TAPECOAT® 20

(Exploded View)

A Coal Tar TAPECOATing that Provides Single-Wrap Protection **PLUS** an Outer Wrap

- ★ **It's more than just a coal tar coating!**
- ★ **It's designed for single-thickness application!**
- ★ **It has advanced features of uniformity!**
- ★ **It assures greater coverage!**
- ★ **It includes a tough outer wrapper!**
- ★ **It combines 20 years of manufacturing and field application experience!**
- ★ **It gives superior protection with greater economy!**

Write for the complete details today.



View of specially-designed machine developed after five years of research by Tapecoat engineers to convert raw materials automatically into TAPECOAT 20.

GEM

The TAPECOAT *Company*

ORIGINATORS OF COAL TAR COATING IN TAPE FORM

1533 Lyons Street, Evanston, Illinois

Telephone: DAvis 8-5220

Sales and Service Offices in New York, Pittsburgh, Charlotte, Birmingham, Houston, Lincoln, Tulsa, Minneapolis, Salt Lake City, San Francisco, Los Angeles, Seattle

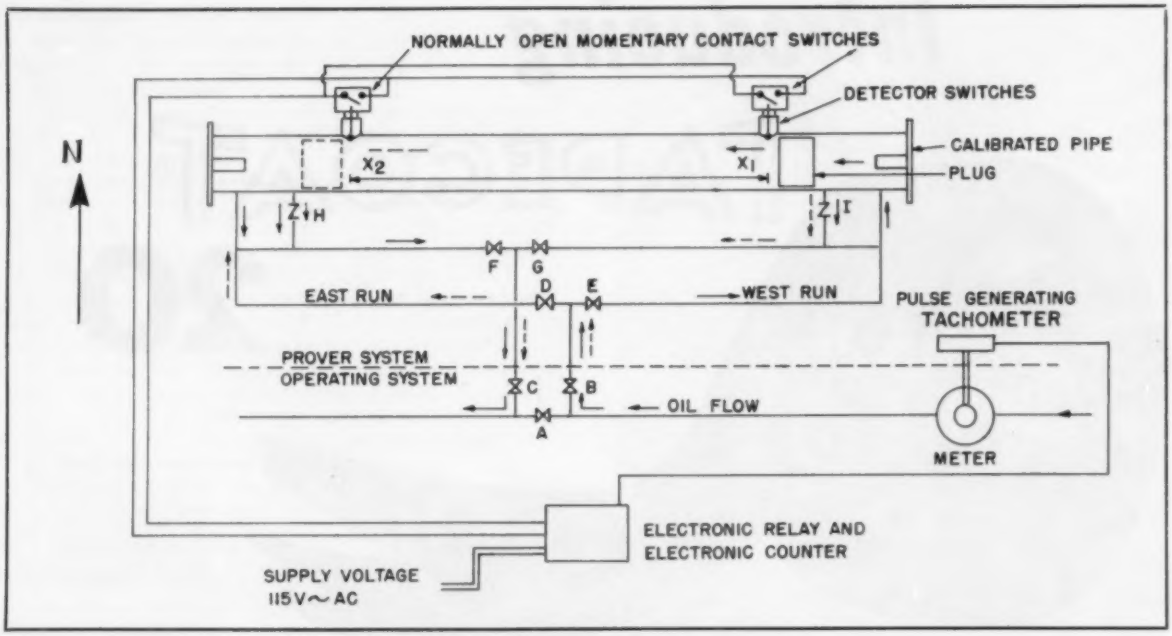


FIG. 1. Schematic diagram of calibrated pipe meter proving system.

be stringently calibrated. The prover system is of the bi-directional piston displacement type, which allows continuous flow through the meter at all times. The tachometer, or pulse generator, is driven by the meter and generates either 1000, 10,000, or 100,000 pulses per bbl of throughput, depending upon the gear ratio of the speed increaser. Ordinarily the countershaft of a meter rotates one revolution per bbl. As the fluid flows through the calibrated pipe, it displaces the plug through a known volume between detector switches. Normally the prover system is isolated from the operating pipeline.

The method of calibration is illustrated in Fig. 1, a schematic of the prover system. First step is to open valves E and F, close valves D and G, open valves B and C, and close block valve A. This directs flow counter-clockwise through B and E into the east end of the calibration pipe. Assuming the plug to be at the east end, it will be displaced by the stream in an east to west direction, a west run. When the plug reaches a precisely determined point, X, it actuates the east detector switch, which closes the electronic switch allowing pulses from the meter to reach the electronic counter where they are recorded.

The counter will continue to record pulses until the plug is displaced through the pipe to point X_2, where it actuates the second detector switch, causing the electronic switch to block pulses from the meter to the counter.

During the west run fluid was displaced through valves F and C back into the operating system. This allows continuous uninterrupted flow through the meter and calibration system at all times. When the plug reaches the west end, flow continues through check valve H and valves F and C.

The meter factor is obtained by comparing the known volume between the detection switches with the volume recorded on the electronic counter.

Successive calibration runs are made in the opposite direction by reversing the positions of valves E, F, D, and G. In this case, the plug would be moved from west to east with valves D and G open and F and E closed.

Partial Delivery Now

Although the pipeline system will not be in complete operation until December 1, some deliveries will begin earlier. As sections of the line were completed, line fill began. Products began going into the line at Pampa on August 10 for delivery to Conway Terminal. Filling of the Kermit-Hobbs line began August 22. Deliveries of propane were scheduled out of the Greenwood and Kearney, first terminals north and west after the line divides at Conway, on October 21, 1960.

Operating Officials

As has been mentioned, Robert E. Thomas is president and chief executive officer of Mid-America. W. N. Deramus III, president of the M-K-T Railroad, is chairman of the board. David A. Roach is vice president; Earl A. Matheney, treasurer; Gilbert V. Rohleder, general superintendent; and D. L. Weinert, superintendent of product movements.

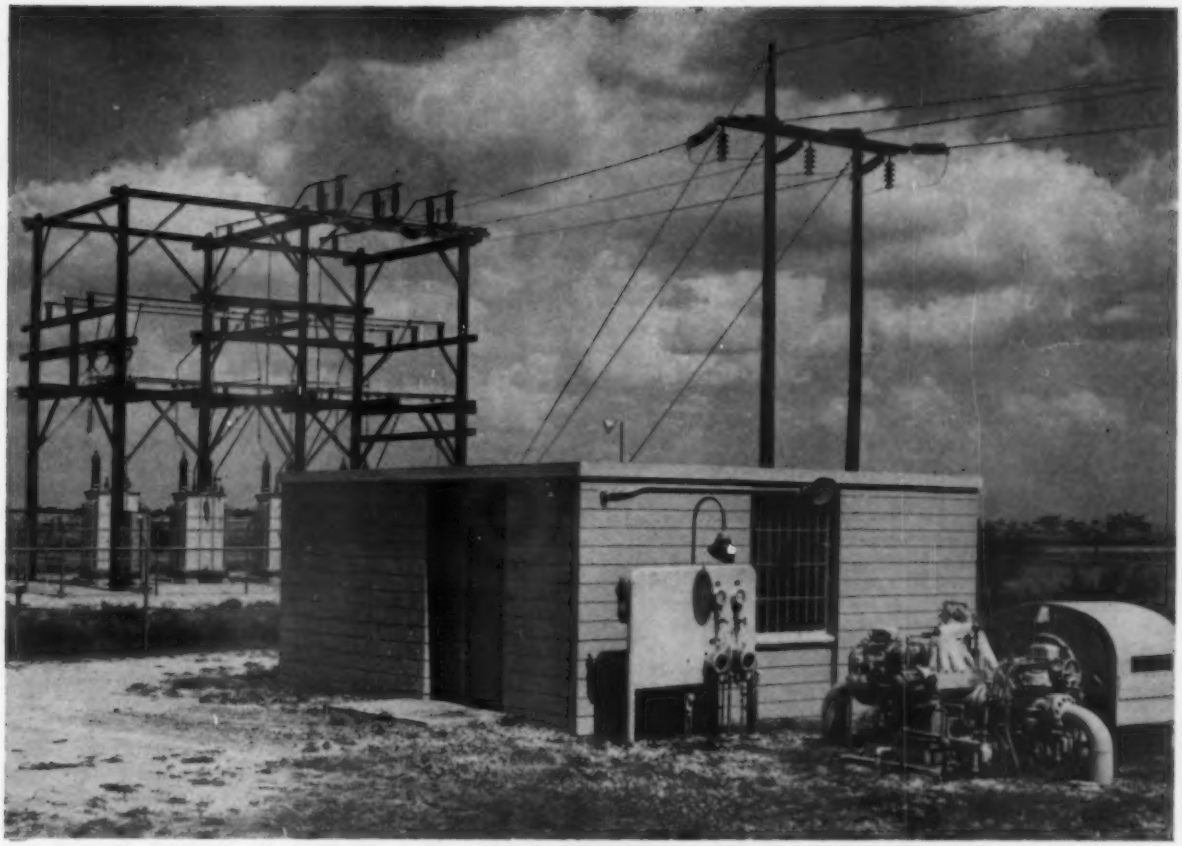
District offices are located at Hobbs, New Mexico; Liberal, Kansas; Moberly, Missouri; and Sanborn, Iowa — each staffed with a district superintendent and maintenance crews. Delivery terminals will be manned by a terminal foreman and several terminal operators.

D. E. Luddeke is superintendent of the Hobbs district, which includes the system up to Tulia, Texas. A pipeline maintenance foreman, mechanical and electrical foreman, gaging foreman, and station foreman, also will be stationed at this point.

The Liberal district, from Tulia to and including Conway, Kansas, will have as its superintendent H. M. McDonald, Jr. On his staff will be a maintenance foreman, mechanical and electrical foreman, gaging foreman, and station foreman at Conway.

R. H. Christy is superintendent of the Sanborn District — Conway to Pine Bend, Minnesota. There will be three terminal foremen in this district in addition to a maintenance foreman and mechanical and electrical foreman.

In charge of the Moberly District will be Bill P. Moon. In addition to the customary maintenance foreman and mechanical and electrical foreman, he will have on his staff four terminal foremen. ★ ★ ★



Purchased electric power provides maximum economy with minimum investment in this compact 750 h. p. station

In West Texas . . .

ANOTHER OIL PIPELINE STATION WHERE ELECTRIC POWER FROM TESCO IS SAVING MANHOURS...MAINTENANCE...MONEY

This compact, fully automatic pipeline station is a typical example of how dependable, low-cost electric power is helping to lower the cost of gas and oil pipeline pumping throughout the oil country. Because it is possible to install the motor outdoors and to control it from any convenient location, investment and labor costs with this type of installation are reduced to a minimum. These savings, together with lower maintenance costs inherent in electric operation, add up to maximum economy in pipeline pumping. Let our power sales engineers show you how you can reduce your pipeline pumping costs with dependable, purchased electric power.

The Opportunity Frontier OF TEXAS

TEXAS ELECTRIC SERVICE COMPANY

General Offices: Fort Worth, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Pipeline Projects

Transco Forms Subsidiary to Build Major LPG Line Across Southeast

Plans to construct the first pipeline to transport LPG from the Gulf Coast into the Southeastern states—a distance of 1080 miles from Mont Belvieu, near Houston, Texas, to Danville, Virginia—have been revealed by Transcontinental Gas Pipe Line Corporation.

The company has formed a wholly-owned subsidiary, Trans-Southern Pipeline Corporation, to build and operate the $63,000,000 pipeline. Operation is expected to begin by November, 1961, with an initial daily capacity of 60,000 bbl. Maximum pipe diameter of the proposed system will be 12 in.

The Trans-Southern line generally will follow the route of the Transco system through Louisiana, Mississippi, Alabama, Georgia, and the Carolinas.

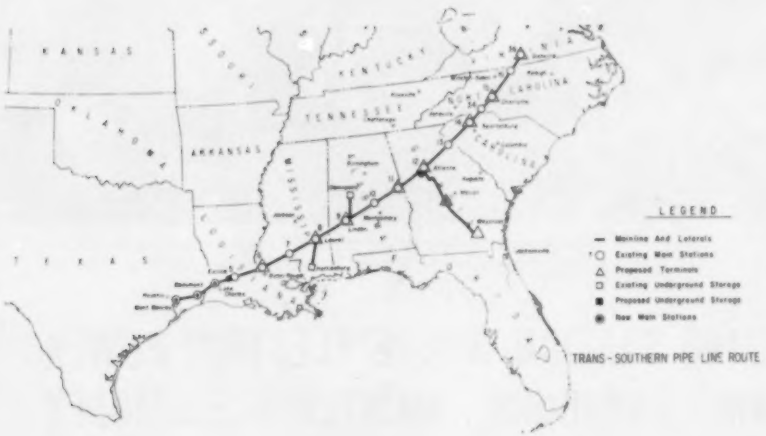
A 215-mile spur will be built from Atlanta to the Georgia-Florida state line. Near Atlanta 1,000,000-bbl-capacity underground storage caverns will be mined in granite substructure. Near Eunice, Louisiana, storage for 350,000 bbl is proposed in salt domes.

A 35-mile spur from Laurel to Hattiesburg, Mississippi, and a 25-mile spur from Linden to Demopolis, Alabama, will extend to existing privately-owned storage facilities.

Points at which Trans-Southern will accept LPG for shipment will be near Mont Belvieu and Beaumont, Texas, and near Lake Charles, Eunice, and Baton Rouge, Louisiana.

Terminals will be located near Baton Rouge; Laurel; Linden; Roanoke, Alabama; Atlanta; Greenville, South Carolina; Charlotte, North Carolina; Danville; and Macon and Waycross, Georgia.

E. Clyde McGraw will be president of the new company and Robert L. Topper executive vice president. McGraw is president of Transcontinental and Topper is his executive assistant.



Proposals Filed for $20,057,600 Construction

Applications by Texas Eastern Transmission Corporation and Algonquin Gas Transmission Company proposing construction of facilities costing $20,057,600 have been accepted for filing by the Federal Power Commission.

Texas Eastern (CP60-122) proposes to construct 66.28 miles of 30-in. loops between Vidor, Texas, and Lambertville, New Jersey, and to install an additional 33,710 hp in four existing compressor stations. The cost is estimated at about $17,592,000.

Algonquin (CP60-124) proposes to construct a 6000-hp compressor station at Stony Point, New York, at an estimated cost of $2,465,600.

Texas Eastern Announces Further Expansion Plans

Texas Eastern Transmission Corporation has announced plans to add approximately 150,000,000 cu ft a day of gas to its delivery capacity. The increase would be achieved in two increments with 75,000,000 cu ft a day being added in 1961 and remainder in 1962, subject, of course, to Federal Power Commission approval.

This expansion is in addition to a 50,000,000 cu ft per day program for which Texas Eastern hopes to have FPC approval in time to make additional capacity available during the 1960-61 winter heating season.

The cost of the 150,000,000 cu ft expansion is estimated at $70,000,000 and the 50,000,000 cu ft program at $17,000,000. Total cost of facilities involved in these two projects, plus development of the Leidy underground storage authorized in August, will amount to more than $125,000,000.

Gas supply for the 150,000,000 cu ft expansion would come primarily from another pipeline supplier in North Louisiana and would involve construction of a pipeline to Texas Eastern's main 30-in. line at Kosciusko, Mississippi. Most of the remaining capacity would be provided by looping this 30-in. system.

James W. Hargrove, financial vice president of Texas Eastern, made the announcement before the Cleveland Society of Security Analysts.

Gas Liquids Line

Mesa Pipeline Company of Midland, Texas, is a new company now constructing a common carrier system to transport gas liquids from the Azalea field of northeast Midland County. The system will include 55 miles of gathering lines, a 10,000-bbl storage tank, and an 8-mile line to connect with Magnolia Pipe Line Company's trunk carrier at Midland.

Murphy H. Baxter of Midland, major operator in the Azalea field, is president of Mesa.

Second Swan Hills Loop

Federated Pipe Lines, Ltd., has awarded a contract to Majestic Contractors, Ltd. for its second loop of a portion of its main crude oil pipeline between the Swan Hills oil field and Edmonton. The project consists of 36½ miles of 16-in. loop of the original 10-in. line.

The new loop section extends beyond a loop built earlier in 1960 and runs from Pumping Station No. 2 site to Fort Assiniboine.

HOW WESTERN GEAR SERVES THE PETROLEUM AND NATURAL GAS INDUSTRIES

HERE'S WHY WESTERN GEAR PIPELINE DRIVES ARE IN WORLD-WIDE SERVICE

Outstanding records of *reliable* performance under all types of operating conditions with a minimum of maintenance attention have established Western Gear pipeline drives as the standard of comparison in the industry. Reliability doesn't just happen...it requires top engineering and manufacturing techniques teamed with broad experience in all types of pipeline drive requirements.

Check these important features found in every W G pipeline drive:

1. Precision manufacture: assures quiet operation, peak efficiency, up to 99%.

2. Tough double helical gearing: precision hobbed and shaved from high alloy steel forgings, heat treated for years of dependable service.

3. Sleeve-type journal bearings: babbitted on base alloy, bronze backed. Larger units have removable caps for easy accessibility.

4. Rugged housings: cast or fabricated, depending on unit size. Generous internal rib and gusset reinforcing for clean appearance and strength.

5. Flexible lubrications systems: standard integral type or special systems to meet any installation requirement.

6. Rigid quality control: close tolerances, mill-to-finished product material inspection including magnetic and ultra-sonic surveys where necessary.

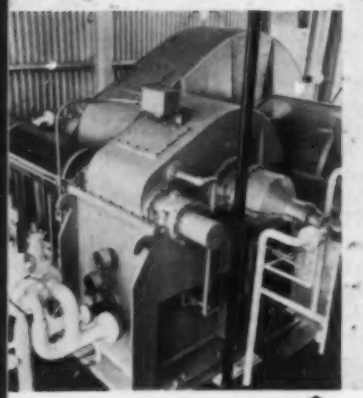
7. Unsurpassed experience: scores of single or multiple stage drives in world-wide service—Transwestern, Columbia-Gulf, Texas Eastern, Transmountain, Warren Petroleum, Union Oil, Trans-Arabian, Petroleos Mexicanos, Spanish Pipeline, Richfield Oil, Great Lakes, Mid-Valley and others.

For complete information on Western Gear pipeline drives, write, wire or phone:

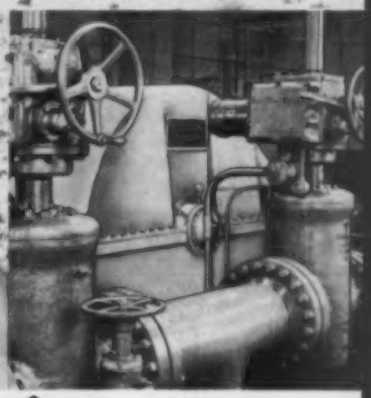
WESTERN GEAR CORPORATION
Industrial Products Division
P.O. Box 126, Belmont, Calif.
LYtel 3-7611

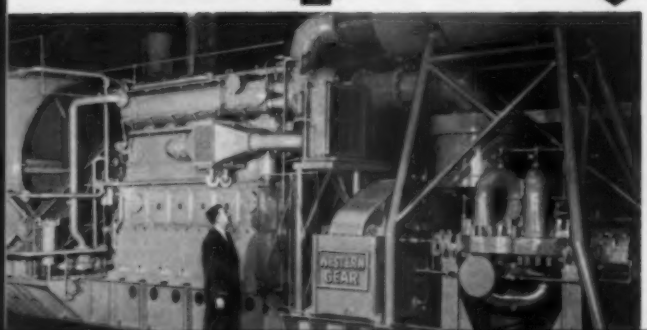
WG PIPELINE DRIVES ARE BACKED BY 70 YEARS OF SERVICE TO INDUSTRY

On the long run... **QUALITY COSTS YOU LESS!**



1. *Western Gear hi-speed unit boosts 600 RPM 925 HP at engine input to a 3550 RPM centrifugal pump at a pumping station of American Independent Oil Co. in Kuwait.*
2. *One of 2 Western Gear Model 300HS150 units installed for El Paso Natural Gas Company in its Leupp, Arizona station... 5750 HP from 1200 RPM electric motor to 8500 RPM centrifugal compressor.*
3. *One of 20 two-stage hi-speed drives which step up 5000 HP 327 RPM engines to centrifugal compressors at 6055 RPM for Columbia-Gulf.*
4. *Western Gear speed increasers like this are used exclusively on Mid-Valley's 1,000-mile pipeline. A total of nine 1200 HP 450/3600 RPM and seventeen 1700 HP 327/3600 RPM units are in service.*





Mid-America Plans Chicago-Superior Condensate Line

The construction of a condensate pipeline between Chicago, Illinois, and Superior, Wisconsin, is in next year's plans of Mid-America Pipeline Company, according to a recent announcement from Robert E. Thomas, president of the company which is now putting finishing touches on 1960's biggest products pipeline construction in the U. S.

The planned 10-in., 405-mile, $21,000,000 line would connect with gathering systems being developed and the existing Interprovincial Pipe Line system in Alberta, Canada, and therefore is contingent on hearings now proceeding before Alberta's Oil and Gas Conservation Board on the construction of several gathering systems in that province, and on export permits. Mid-America is supporting two applicants: Hydrocarbons Pipeline Limited and Provincial Pipeline Limited, both of which propose to gather condensates to pump into the Interprovincial system.

Initially the line would have three pumping stations and a daily capacity of 26,000 bbl. Thomas said that in 1962 and 1963 three additional pumping stations would be added to the new condensate line to bring the total capacity to 55,000 bbl per day.

Thomas said studies show that while the Alberta area of Canada probably will consume most of its own propane, butanes, and condensates, an export market must be found and the studies further show the Chicago refineries to be the logical outlet.

Discussions with potential shippers have been initiated and financing arrangements will be completed at a later date, Thomas stated.

Contracts Awarded for Canadian Gas Import Lines

Construction contracts for the 1400-mile pipeline project to bring natural gas from Alberta, Canada to California have been let.

In San Francisco, Pacific Gas and Electric Company, the principal project sponsor, announced awards for 1000 miles of the project. In Calgary, the Alberta Gas Trunk Line Company, Ltd., disclosed the names of low bidders for the Alberta section. The total project will cost nearly one-third billion dollars, said Norman R. Sutherland, PG&E president.

Clearing of rights-of-way and the preparation of road, railway, and river crossings for the 36-in. diam pipeline will begin in California, Oregon, Washington, Idaho, and British Columbia as soon as the contractors can move in their equipment.

Pipe already is being delivered to one welding and wrapping yard at Sprague River, Oregon, and other deliveries will begin soon at Burney and Napa, California, and a number of other points in the Pacific Northwest.

PG&E awarded a contract for the 291-mile California section to the H. C. Price Company of Bartlesville.

Pacific Gas Transmission Company, a PG&E affiliate which will own and operate the Oregon-Washington-Idaho section, awarded two contracts for that area. One went to H. C. Price Company for the 146 miles from Rosalia, Washington, to the Idaho-British Columbia border. The other went to the joint-venture organization of Western Pipeline, Inc., of Austin, Texas, and J. P. Neill and Company, Inc., of Dallas, for the 468-mile installation from the California-Oregon boundary to Rosalia, Washington.

The Bechtel Corporation has been retained as engineering manager for the PGT construction.

PG&E President Sutherland said that separate contracts will be awarded later for construction of compressor stations, maintenance bases, and major river crossings along the route.

The huge project, involving elevations from sea level to mile-high mountains, 14 major river crossings and other big construction problems, is scheduled for completion in the winter of 1961-62. It will deliver an average 415,000,000 cu ft of natural gas daily to PG&E for distribution in northern and central California. Along the route, PGT also will deliver additional gas to El Paso Natural Gas Company for distribution to local utilities in the Pacific Northwest.

Alberta and Southern Gas Company, Ltd., wholly owned PG&E subsidiary based in Calgary, will purchase gas from Alberta producers for PG&E.

In a related project, Montana Power Company will import gas through a lateral from the facilities of Alberta Gas Trunk Line Company, Ltd.

On the Canadian portion of the project Alberta Gas Trunk Line Company, Ltd., has awarded 351 miles of main line, all 30 and 36-in., and 122 miles of laterals for gathering gas from some of the major fields in the foothills area.

The job was divided into five sections. Three contractors won the awards. One contractor, a joint venture company, is composed of four other firms, three from Alberta and one from British Columbia. Still to be let are some 200 to 250 miles of additional laterals, involving another $13,000,000.

Work began immediately after the awards of the contracts. Considerable progress is expected in right-of-way clearing and grading, stringing, and even some pipelaying this fall and through the winter. A great deal of terrain is muskeg, which is much easier to work on in winter than when it is thawed in summer. Four major and several minor river crossings are also to be put in this winter. About 20 miles of line is scheduled to be laid in the same period. The rest of the pipelaying will be deferred until next summer, with a high speed program calling for the final tie-in weld before November 1, 1961.

Here is the full list for the first phase of the big project:

Section 1, 113 miles of 36-in. main line from the Alberta-British Columbia border in the Crowsnest Pass area of southwestern Alberta to Priddis, west of Calgary. Majestic Contractors, Ltd., Edmonton and Toronto.

Section 2, 113 miles of 36-in. main line from Priddis to a point near Rocky Mountain House. Alberta Consolidated Pipe Line Builders, a joint venture of Mannix Company, Ltd., Piggott Construction, Ltd. (both of Calgary) Banister Construction Company, Ltd., of Edmonton, and Marine Pipeline and Dredging, Ltd., Vancouver.

Section 3, 63 miles of 30-in. main line from Rocky Mountain House to West Cynthia, and 38 miles of 22-in. lateral from Rocky Mountain House to Homeglen-Rimbey. Majestic Contractors, Ltd.

Section 4, 62 miles of 30-in. main line from West Cynthia to West Whitecourt and 20 miles of 22-in. lateral to the Whitecourt field. Dutton-Williams Brothers, Ltd., Calgary.

Section 5, 64 miles of 16-in. lateral from the main line near the Waterton Park gas field to the Montana border at Carway. Alberta Consolidated Pipe Line Builders.

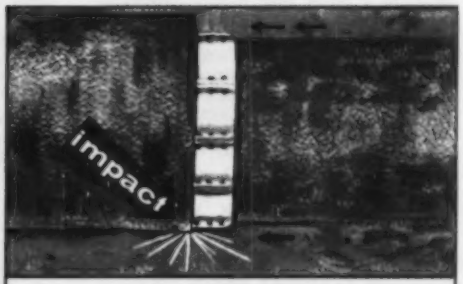
Work is also under way on the 108 miles of 36-in. main line for Alberta Natural Gas Co. from the provincial boundary in the Crowsnest Pass to the Idaho boundary at Kingsgate-Eastport. Contract for this main export pipeline was awarded to Price-Poole of Canada, Ltd. It will cost over $10,000,000. The contract is a joint venture firm comprising H. C. Price of Canada, Ltd., Calgary, and Poole Construction Company, Ltd., Edmonton.

Both the Alberta Trunk foothills system and the Alberta Natural main line are parts of an integrated pipeline system for the export of nearly 600,000,000 cu ft per day of Alberta natural gas to California and the Pacific Northwest states.

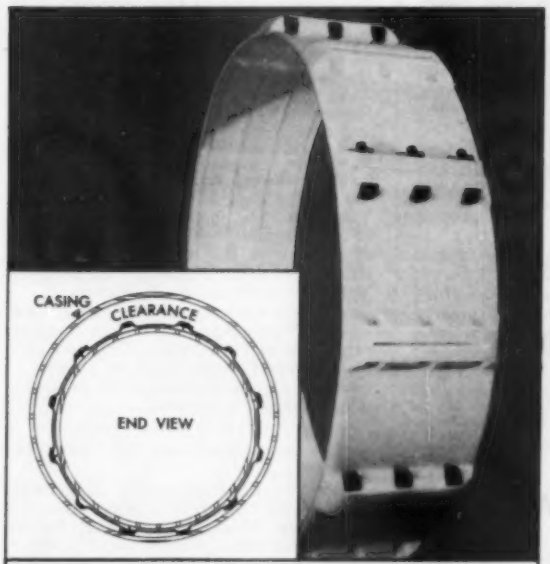
NEWS FROM DOWN THE LINE!

WmSON BIG-INCH M-2 THINSULATORS® MEET RUGGED TEST IN NEW JERSEY TURNPIKE CROSSING

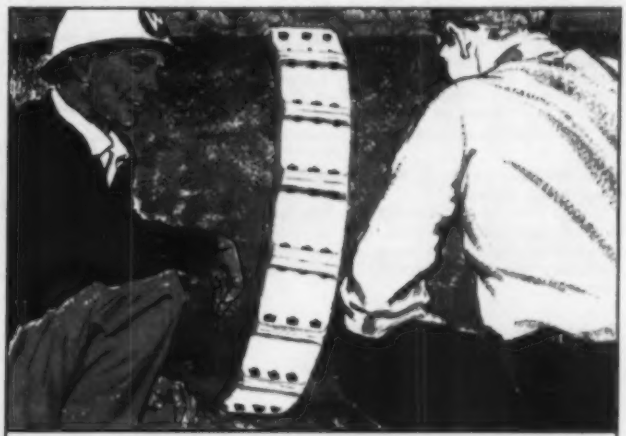
❶ "We'll pull the 36" drag section through this 275' casing. The casing has a slight dog-leg in the center which will make the pull a really tough test of the THINsulators."



❷ "M-2 THINsulators are high-density polyethylene products, resistant to fracture under tremendous impact. Most other plastic insulators are fiberglas reinforced polyesters that don't have the impact resistance, so breakage rates are high."



❸ "The high density polyethylene gives the M-2 such strength it can be made more compact than other insulators, allowing more clearance. It's flexible, so it conforms to the pipe for uniform coating loading . . . and the low coefficient of friction makes it slide like it's greased."



❹ "The tremendous force of the pull caused the lead THINsulator to absorb most of the shock. It twisted slightly but remained intact. All hands agree this is the best plastic casing insulation they have used."

❺ "Consider the economy of M-2 THINsulators. They cost no more than other plastic insulators, and breakage is **practically unknown.** Bend 'em, beat 'em, you can't break 'em."

T.D. Williamson, Inc.

P. O. BOX 40 • TULSA 2, OKLAHOMA

REPRESENTATIVES AROUND THE WORLD

Write Dept. B for Technical Bulletin on the M-2 THINsulator

WITH THE PIPELINE CONTRACTORS

● **Alberta Consolidated Pipe Line Builders.**

Alberta Gas Trunk Line Company, Ltd. —113 miles of 36-in. from Priddis, Alberta, to a point near Rocky Mountain House, and 64 miles of 16-in. from the main line near Waterton Park gas field to the Montana border near Carway. Alberta Consolidated is a joint venture of Mannix Company, Ltd., and Piggott Construction, Ltd., both of Calgary, Banister Construction Company, Ltd., Edmonton, and Marine Pipeline and Dredging, Ltd., Vancouver.

● **Bechtel Corp., 220 Bush St., San Francisco 4, California.**

Michigan Wisconsin Pipe Line Co.—84 miles of 24-in. between the Mississippi River and Sandwich, Illinois; approximately 47 miles of 30-in. in Lake, Porter, and La Porte counties, Indiana; and approximately 14 miles in Berrien County, Michigan.

Esso Standard (Libya) Inc.—a 100-mile, 30-in. crude oil pipeline from the Zelten field in Libya, north to Marsa el Brega on the Gulf of Sirte.

● **O. R. Burden Construction Corp., Box 5216, Tulsa, Oklahoma.**

Natural Gas Pipeline Co. of America—58 miles of 36-in. in the vicinity of Concordia and Ford, Kansas. R. M. Jones is supervising. Field office: Glasco, Kansas.

Peoples Gulf Coast Natural Gas Pipeline Co.—37 miles of 30-in. in Wharton, Ft. Bend, and Harris counties, Texas.

● **D. Michael Curran & Co., Eklund Bldg., Great Falls, Montana.**

Great Northern Pipeline Co.—first section of proposed 110-mile, 6 and 10-in. crude line from Newburg, Wiley, and Glenburg pools of North Dakota to Minot.

● **Dunn Bros., Inc., 805 Mercantile Securities Bldg., Dallas, Texas.**

Texas Eastern Transmission Corp.—approximately 39 miles of 24-in. in Pennsylvania from Bellefonte to Waterford, with O. K. Epperson supervising.

Tennessee Gas Transmission Co.—25 miles of 30-in. in the Hamburg, New York, area, with O. A. Price supervising.

Michigan-Wisconsin Pipe Line Co.—60 miles of 30-in. from St. John, Indiana, to Bridgman, Michigan, under the supervision of H. W. Gandy.

Texas Gas Transmission Corp.—56 miles of 12-in. in Indiana between Bedford and Coalmont, under the supervision of Alton Bean.

● **Dutton-Williams Brothers, Ltd., North Canadian Oil Building, Calgary, Canada.**

Alberta Gas Trunk Line Company, Ltd. —62 miles of 30-in. from West Cynthia to West Whitecourt, Alberta, and 20 miles of 22-in. lateral from this main line to the Whitecourt field.

● **R. H. Fulton & Co., Box 1526, Lubbock, Texas.**

Natural Gas Pipeline Co. of America —188 miles of 24-in. from Weatherford, Oklahoma, to Ashland, Kansas.

Michigan-Wisconsin Pipe Line Co.—250-mile, 24-in. in Kansas, Missouri, Iowa. Also 24 miles of 6-in. near Sun Prairie, Wisconsin.

● **Hall Construction Co., 1105 N. Carlton, Liberal, Kansas.**

Panhandle Eastern Pipe Line Co.—a 330-mile, 4 through 12-in. gathering system in western Kansas. Supervising are Mike Bell and M. E. Banning.

● **Houston Contracting Co., 2807 Buffalo Speedway, Houston 6, Texas.**

Texas Gas Transmission Corp. — four 30-in. loops consisting of approximately 25 miles in Quachita, Caldwell, La Salle, Grant, Rapides, and Evangeline parishes, Louisiana. Headquarters: Monroe. Superintendent: L. A. Young.

● **C. S. LeNoir Construction Co., Box 798, Austin 64, Texas.**

Northern Natural Gas Co.—110 miles of 16-in. from Ellendale, Minnesota, to LaCrosse, Wisconsin; 17 miles of 10-in. between Rushford and Winona, Minnesota; and 30 miles of 10-in. near Hutchinson, Minnesota. Field office: Rushford, Minnesota — with one also to be set up at Hutchinson. W. B. Williams is general superintendent; R. E. McManus is office manager; and spreadmen are C. H. LeNoir and James Keene.

● **Majestic Contractors Ltd., 49 Jackes Ave., Toronto 7, Ontario, Canada.**

Federated Pipe Lines Ltd.—14 miles of 6-in. and 19 miles of 6 through 8-in. crude oil pipeline in the Swan Hills area, Alberta, under the supervision of K. B. Killingsworth and Jeff Minter. Also, 41 miles of 16-in. from Oliver to Highbridge, Alberta, under the supervision of Jeff Minter at Morinville. Also, approximately 37 miles on 16-in. loops northwest of Edmonton.

Michigan-Wisconsin Pipe Line Co. — 60 miles of 30-in. near Joliet, Illinois, where R. L. Leonard is supervising.

Alberta Gas Trunk Line Company, Ltd. —113 miles of 36-in. from Alberta-British Columbia border to Priddis, Alberta. Also 63 miles of 30-in. from Rocky Mountain House to West Cynthia and 38 miles of 22-in. from Rocky Mountain House to Homeglen-Rimbey.

● **Mannix Co. Ltd., 737 Eighth Ave., S. W., Calgary, Alberta, Canada.**

Pembina Pipe Line Ltd.—70 miles of 3 through 10-in. in the Pembina oil fields of Alberta, part of a continuing contract of which over 500 miles have been constructed to date. Headquarters: Drayton Valley. Superintendent: S. Steffen.

Northern Ontario Pipe Line Crown Corp.—compressor station with building extensions at Port Arthur, Ontario—part of the Trans-Canada Pipe Line system. J. Hobbs is superintendent and M. Zambory office manager at Kenora.

● **McVean and Barlow, Inc., Box 151, Odessa, Texas.**

Mid-America Pipeline Co.—231 miles of 4, 6, and 8-in. LPG pipeline from Artesia, New Mexico, to Midkiff, Texas, under a sub-contract from Williams Bros. Co.

● **Missouri Valley Dredging Co., Box 1592, Burlington Station, Omaha 8, Nebraska.**

Mid-America Pipe Line Co. — Kansas and Missouri river installations.

● **Montin-Harbert Pipe Line Construction Co., Inc. 2808 First National Bldg., Oklahoma City, Oklahoma.**

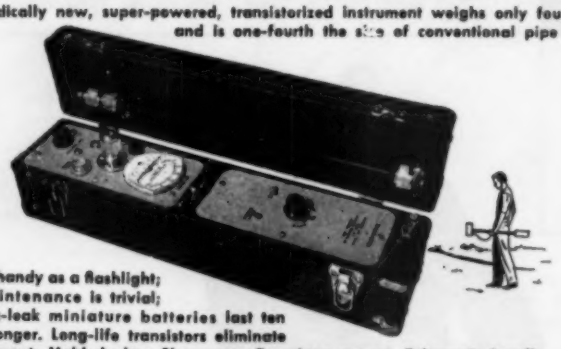
Mustang Fuel Corp. — 155 miles of 12-in. natural gas pipeline system in central Oklahoma.

● **J. P. Neill and Company, Meadows Building, Dallas, Texas.**

Pacific Gas Transmission Company—468 miles of 36-in. from California-Oregon boundary to Rosalia, Washington, as joint venture with Western Pipeline, Inc., Austin, Texas.

The MINIATURIZED-PRECISION WILKINSON Line Locator Model W-3

This radically new, super-powered, transistorized instrument weighs only four pounds and is one-fourth the size of conventional pipe locators.



It is as handy as a flashlight; the maintenance is trivial; the non-leak miniature batteries last ten times longer. Long-life transistors eliminate replacement. Molded glass fibre cases. Transistor ear set. Telescopic handle. Etches circuitry. Contained in carrying case.

WILKINSON PRODUCTS COMPANY
"SINCE 1940"
3987 Chevy Chase Drive • Pasadena 3, California • SYlvan 0-4314

● **Panama, Inc., 1801 Tennessee Bldg., Houston 2, Texas.**

Continental Oil Co. — 8 miles of 24-in. and 65 miles of 16-in. beginning in Lake Charles, Louisiana, and extending to the Maurice-Milton areas in Vermilion Parish. Headquarters: Iowa, Louisiana. Superintendents: T. O. May and C. J. Hendrickson.

● **Panama-Williams Corp., 1418 Melrose Bldg., Houston, Texas.**

Northern Natural Gas Co.—150 miles of 30-in. loops in Iowa, Minnesota, Nebraska, Kansas, and Oklahoma, under the supervision of M. E. Sutton at Clarion, Iowa.

Peoples Gulf Coast Natural Gas Pipeline Co.—60 miles of 30-in. pipeline from Nacogdoches, where field office is located under the supervision of W. H. Shiflett, to Leggett, Texas.

● **Parkhill Truck Co., Box 3807, Tulsa, Oklahoma.**

Natural Gas Pipeline Co. of America—pipe stringing under a sub-contract from River Construction Co. for loops in Iowa. Superintendent: Leon Weston.

Northern Natural Gas Co.—pipe stringing under a sub-contract from Panama-Williams Corp. for various loops in Iowa, Minnesota, Nebraska, Kansas, and Oklahoma. Field office: Ogden, Iowa.

● **Pipe Line Technologists, Inc., 3431 Alabama, Houston, Texas.**

Seadrift Pipeline Corp. — a 108-mile products pipeline from Union Carbide Corp.'s Seadrift, Texas, plant to Humble Oil & Refining Co.'s King Ranch plant at Ella, Texas.

● **Pipeline Welding Co., 5100 E. 17th St., Tulsa, Oklahoma.**

Northern Natural Gas Co.—163 miles of 3 to 24-in. in Minnesota.

● **Prairie Construction Co., Box 1526, Lubbock, Texas.**

Northern Natural Gas Co.—114 miles of 2 to 12-in. in Iowa.

● **H. C. Price Co., Price Tower, Bartlesville, Oklahoma.**

Rocky Mountain Natural Gas Co., Inc. — a 172-mile transmission line from Colbran, Colorado, south to Montrose, Colorado. Bill Millburn is office manager, and K. N. "Spike" Adkins is in charge of construction of the cross-country line.

Peoples Gulf Coast Natural Gas Pipeline Co.—83 miles of 30-in. from Oraville, Illinois, southwest to near Puxico, Missouri. Field office: Murphysboro, Illinois. W. H. Olrich is superintendent and Allen Stottler is office manager.

Pacific Gas Transmission Company—146 miles of 36-in. from Rosalia, Washington, to the Idaho-British Columbia border.

● **Price-Poole of Canada, Ltd., Calgary and Edmonton, Canada.**

Alberta Natural Gas Company – 108 miles of 36-in. from Crowsnest Pass to the Idaho boundary at Kingsgate-Eastport. Joint venture of H. C. Price Company of Canada, Ltd., Calgary, and Poole Construction Company, Ltd., Edmonton.

● **R. E. Reutzel Co., Box 15, Fremont, Nebraska.**

Northern Natural Gas Co.—89 miles of 2 to 6-in. in Iowa.

● **River Construction Corp., Box 9127, Ft. Worth 7, Texas.**

Natural Gas Pipeline Co. of America—95 miles of 36-in. in Iowa, from Haskins to Rose Hill and from Stennett to Pacific Junction. Field office: Washington, Iowa. Spreadman: Harold Mehail.

Peoples Gulf Coast Natural Gas Pipe-Line Co.—75 miles of 30-in. in Arkansas from Galloway to Newport. T. M. Tatom is spreadman.

● **Robb Construction Co., Ltd., 1237 Albert St., Regina, Saskatchewan, Canada.**

Saskatchewan Power Corp. — the Assiniboia and Ormiston-Claybank transmission lines, consisting of approximately 104 miles of 6 and 4-in. L. Brassard is superintendent.

● **Rosson-Richards Companies, Box 35037, Houston 35, Texas.**

Natural Gas Pipeline Co. of America—24, 30, and 36-in. river weights between Clinton, Oklahoma, and Chicago, Illinois. Superintendent: J. Alexander.

Peoples Gulf Coast Natural Gas Pipeline Co.—24, 30, and 36-in. river weights between Katy, Texas, and Chicago, Illinois.

● **Sam Carline, Inc., Box 138, Berwick, Louisiana.**

Texas Gas Transmission Corp. — a 12-in. crossing of the Atchafalaya River 3 miles north of Baldwin, Louisiana.

● **Shamrock Construction Co., Box 1177, Lansing, Michigan.**

Buckeye Pipe Line Co.—96 miles of 10-in. between Lima and Lebanon, Ohio. Field office: Urbana. Superintendent: Frank Parks.

HYDROSTATIC PIPELINE TESTING

EXPERIENCE MAKES THE DIFFERENCE

...and a world of experience in testing thousands of miles of pipelines makes the difference in every Williams testing job.

Williams
PRESSURE SERVICE COMPANY

Call Shreveport 4-2678

2000 BECK BUILDING
SHREVEPORT, LOUISIANA

SPECIALLY DEVELOPED EQUIPMENT • COMPLETE TESTING SERVICE
EXPERIENCED TESTING ENGINEERS

Control Board of coating and wrapping schedules in the Plant Office.

Working for You at spi

President Baird checks on final shipment.

All these people and many others, each skillfully trained for his particular job, are working on your pipe. Each one is seeing to it that your pipe is coated and wrapped precisely to your specifications, and that it is shipped at the exact time and to the exact place that you have requested.

Efficient office force keeps adequate records to prevent any error in filling your order.

V.P. Wilson discusses plans with V.P. Vondrasek.

Count on SPI to co-ordinate their work to your job

standard pipeprotection inc.

3000 SOUTH BRENTWOOD BLVD. • ST. LOUIS 17, MISSOURI

● **Sharman, Allen, Gay & Taylor, Inc., Box 13152, Houston, Texas.**

Peoples Gulf Coast Natural Gas Pipeline Co.—60 miles of 30-in. from Hope, Arkansas, to Bloomburg, Texas. Field office: Hope. Superintendent: E. D. Singleton.

● **Sheehan Pipe Line Construction Co., 514 National Bank of Tulsa Bldg., Tulsa, Oklahoma.**

Gulf Refining Co.—laying 23 miles of 10-in., taking up 20 miles of 10-in., and reconditioning 10 miles of 10-in. in Illinois. Field office: Carlyle. Superintendent: C. M. Brown.

● **Somerville Construction Co., 6648 Fulton Rd., Ada, Michigan.**

Michigan-Wisconsin Pipe Line Co.—70 miles of 30-in. pipeline loops in Michigan: from Howard City to Jenison and from Pullman to Niles. Field office: Rockford. Superintendent: Harold Cook.

● **Stanley-Bledsoe Corp., 612 Daniel Bldg., Tulsa 3, Oklahoma.**

Peoples Gulf Coast Natural Gas Pipeline Co.—57 miles of 30-in. from Monticello to Shelbyville, Illinois, with Woody Nolen supervising at Sullivan, Illinois.

San Diego Gas & Electric Co.—51 miles of 30-in. from San Diego to Rainbow, California, with D. L. Franklin supervising at Del Mar, California.

● **Turriff-Burden, Ltd., Box 5216, Tulsa, Oklahoma.**

Iraq Petroleum Co. Ltd.—315 miles of 30 and 32-in. pipeline from Kirkuk to the Syrian border, connecting Rumaila and Fao. W. T. Barker manages the project office in London, England. Field construction superintendent is John H. Miller; assistant superintendent is Arnold Smith; and manager of the field office in Baiji, Iraq, is G. E. Suagee.

● **Vaughn and Taylor Construction Co., Inc., Box 3266, Odessa, Texas.**

Monterrey Oil Co.—21 miles of 4 through 14-in. in the vicinity of Frankel City, Texas. Superintendent is G. C. Laman.

● **Western Pipeline, Inc., 311 East 11th Street, Austin, Texas.**

Pacific Gas Transmission Company—468 miles of 36-in. from California-Oregon boundary to Rosalia, Washington, as joint venture with J. P. Neill and Company, Inc., Dallas, Texas.

● **J. O. (Red) Willett Pipe Line Stringing Corp., Box 2836, Monroe, Louisiana.**

Peoples Gulf Coast Natural Gas Pipeline Co.—to unload and rack, haul and string approximately 60 miles of 30-in. Headquarters: Hope, Arkansas. Superintendent: J. W. Cathey.

● **Williams Bros. Co., National Bank of Tulsa Bldg., Tulsa, Oklahoma.**

National Iranian Oil Co.—a 516 mile, 8-in. petroleum products line in Iran from Rey, near Tehran, northeast to Meshed.

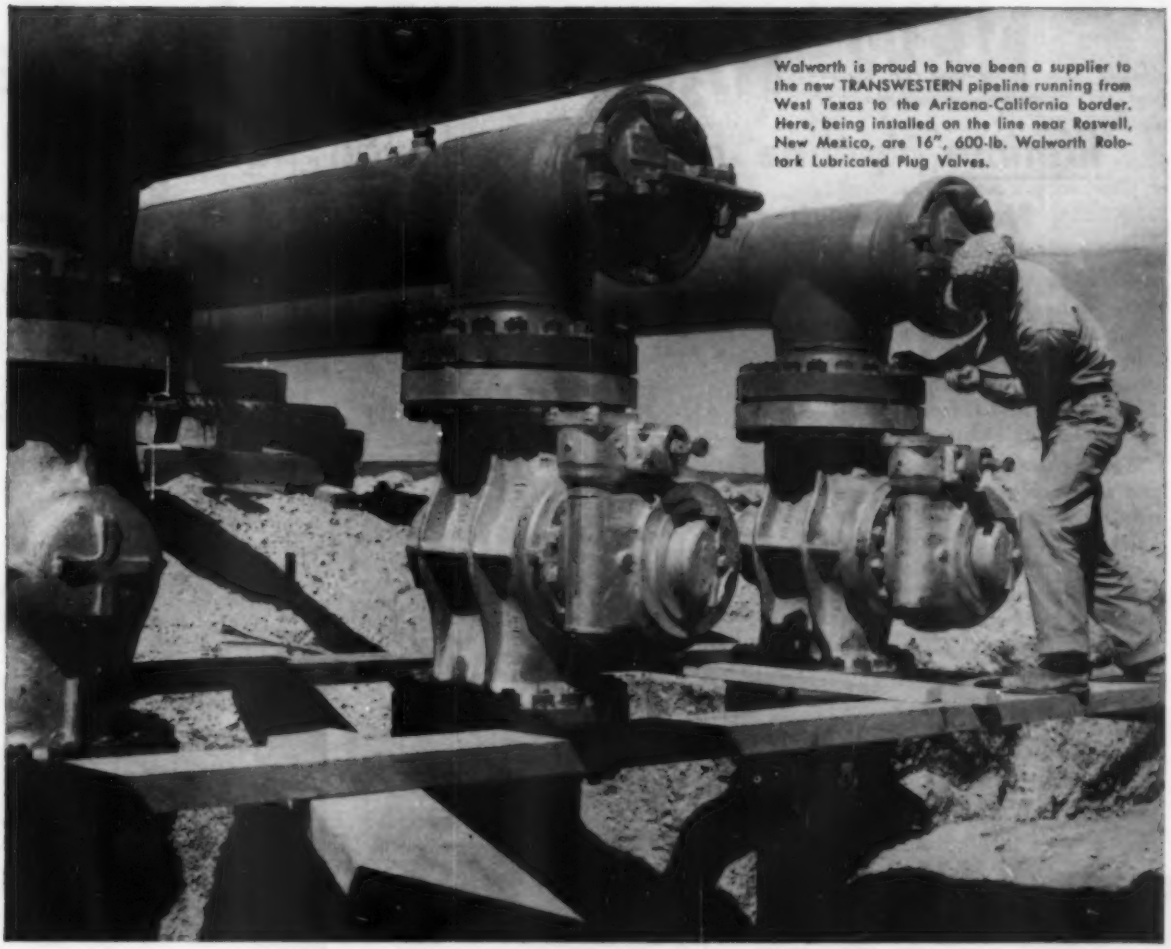
Alaska Pipeline Co.—74 land miles of 12-in. pipeline from the Kenai Unit gas field to Anchorage, Alaska.

Mid-America Pipe Line Co.—four construction spreads have now completed 541 miles of this 1800-mile LPG pipeline.

Cia. Shell de Venezuela—expansion of its North Terminal system at Puerto Miranda and Cabimas on the northeast shore of Lake Maracaibo, Venezuela.

Calnev Pipe Line Company—230 miles of 8-in. products line from Las Vegas, Nevada, to Colton, California. Field office at Las Vegas, Harland Evens, superintendent. Starting date: October 15.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Walworth is proud to have been a supplier to the new TRANSWESTERN pipeline running from West Texas to the Arizona-California border. Here, being installed on the line near Roswell, New Mexico, are 16", 600-lb. Walworth Rolotork Lubricated Plug Valves.

RELY ON *ROLOTORK* ...BY WALWORTH

No matter what the service, you can rely on the Walworth Rolotork Lubricated Plug Valve to operate easily and dependably in handling gas, crude or finished petroleum products. In service throughout the world, these valves have proved their complete dependability. Why? Because Walworth manufactures a *better* LPV.

The Rolotork turns more easily, closes tighter, and requires less maintenance. It can be lubricated without removing the lubricant fitting. The gear housing design permits simple attachment of lubrication and handwheel extensions without modifying the gearcase. And vertical and circumferential lubricant grooves completely frame the port openings, preventing leakage.

These are just some of the features that make Walworth LPV's better. For additional information, write Walworth Company, Lubricated Plug Valve Division, 3517 Polk Avenue, Houston 23, Texas.

WALWORTH *750 Third Avenue, New York 17, N. Y.*

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

WALWORTH SUBSIDIARIES: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC.

NEW HANDLEY-INDUSTRIES

lifetime pipeline markers and sign posts . . .

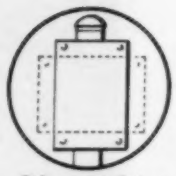
Never need painting. Won't rust or shatter!

This new, non-metallic* pipeline sign post saves money three ways. Chemically bonded color eliminates painting maintenance. The posts are light and easy to handle and store, come conveniently packaged 5 to a container. And they're sturdy, even gun shots won't shatter them.

Equally important, both pipeline markers and sign posts can be designed to meet your specific requirements. Marker posts and side-mounted sign posts may be equipped with cathodic terminal caps or vent caps. Climbers may also be added.

A 5" square foot piece is solvent-welded to the bottom of the post to prevent rotation. It anchors the post securely in the ground.

IT WILL PAY YOU TO GET THE FACTS FROM HANDLEY-INDUSTRIES. WRITE TODAY.



Side-mounted sign, (vertical or horizontal). Front view shown above.

Top-mounted pipeline sign post (vertical or horizontal). *Rear view shown above.*

Marker Post with cap

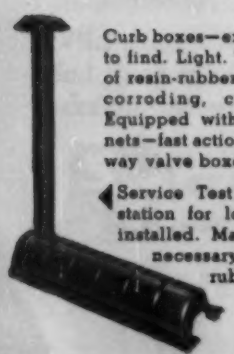
Marker Post with vent cap

Cathodic terminal cap for pipeline marker post

End call backs with attractive H-I outside meter boxes. Available as shown, or for recessed installation. Made of tough resin-rubber compound*.

Master Poly-Trol *automatic* gas shut-off valve. Shuts-off gas in event of over-pressure, underpressure, excessive high temperature, and flooding. Serves also as a tamper-proof manual shut-off.

H-I Cathodic Terminal Box Landscape engineered, and non-corroding*. Leads are attached to the terminal block in the cap for easy testing.



Curb boxes—extension-type. Easy to find. Light. Tough. Safe. Made of resin-rubber compound*. Non-corroding, collapsible type. Equipped with permanent magnets—fast action on finders. Roadway valve boxes also available.

Service Test Station. Provides a test station for leak surveys. Permanently installed. Makes random probing unnecessary. Made of tough resin-rubber compound*.

specifications:

Post Length: 7' (other sizes available on request)

Post Diameter: 3½"

Wall Thickness: 3/16".

**A. B. S. Polymer*

HANDLEY-INDUSTRIES, INC.

903 BELDEN ROAD • JACKSON, MICHIGAN

Pipeline Personals

H. N. VerSoy

H. Nelson VerSoy, who for the past six years has served as H. C. Price Company's Gulf division manager at Harvey, Louisiana, is now general superintendent, pipe coating division, Bartlesville, Oklahoma. He is succeeded by **Leo C. Carle,** assistant Gulf division manager for the past nine years. Promoted to plant superintendent at Harvey is **Vernon J. Jones.**

L. C. Carle

V. J. Jones

Appointments of **M. L. DeCraene** to assistant general superintendent of pipelines, **H. E. Boomer** to administrative assistant to the president, **T. H. Beals** to chief planning engineer, and **R. W. Lindgren** to superintendent of development engineering are announced by Natural Gas Pipeline Company of America and associates.

Mid-America Pipeline Company has elected to its board of directors **John Hawkinson,** vice president and treasurer of Central Life Assurance Company of Des Moines, Iowa, and also a director of Federation Chemical Company, Trinidad-based ammonia plant controlled by W. R. Grace Company, and the Douglas Oil Company of California.

Key men promoted to new positions in Continental Pipe Line Company include: **S. W. Ogan,** from general superintendent of operations to manager of construction; **R. E. Lombard,** former Oklahoma-Kansas-Illinois district superintendent, succeeding Ogan; **W. F. Burke,** former Rocky Mountain district superintendent, succeeding Lombard; **R. W. Lee,** temporary North Texas district superintendent, succeeding Burke; and **J. L. Walker,** from assistant superintendent of Cherokee Pipe Line Company to superintendent of the North Texas district. **T. W. Sigler,** former assistant superintendent of the Oklahoma-Kansas-Illinois district, is now manager of new plans and projects. **W. E. Laughlin** is new administrative coordinator and is succeeded in his former position as Louisiana district superintendent by **W. P. Ilgen, Jr.,** who has been serving as assistant superintendent of Yellowstone Pipe Line Company.

Atlantic Seaboard Corporation has promoted **Charles Andrew Waggener,** storage engineer, to supervisor of the storage engineering department.

Promoted to supervisor of operations in Northern Natural Gas Company's Omaha, Nebraska, office, is **Harold Barrett** who has held the job of gas engineer, gas supply, since 1956.

George H. Supple, manager of West Coast Pipe Lines of Mobil Oil Company, will retire December 31 after 36 years of service. **John S. Black,** president of South Saskatchewan Pipe Lines, will be Supple's successor. Black will act as assistant manager until the end of the year.

Superintendents of The Buckeye Pipe Line Company's newly-established Lima, Cleveland, and Toledo divisions, respectively, are **L. A. Miller, P. T. Dunkle,** and **E. R. Shearer.** These divisions include both crude oil trunk line and refined products operations in their respective areas.

Charles E. Terrell, superintendent of Southern Natural Gas Company's measurement department since 1930, has retired. He has been named editor of the forthcoming American Gas Association "Gas Measurement Manual" and will devote his time to this work until the manual is published.

Lowell E. Anderson, Service Pipe Line Company's division chief engineer in Wyoming — who, in 1959, was assigned to a special project with Pan American International Oil Company to oversee construction of a pipeline in Argentina — is being transferred to Tulsa, Oklahoma, on special assignment. He will be replaced in Wyoming by **R. H. Christman** who has been acting division chief engineer.

MID-AMERICA

BUILDS FOR ENDURANCE

Mid-America Pipeline Company's new line will carry LPG all the way from the West Texas and New Mexico area to Minnesota and Wisconsin—2,200 miles of pipe. A big job of construction. Big investment in money too! Pipelines must be built to last.

That's why Reilly Hot Service Enamel with HS X-10 Primer and Reilly Intermediate Enamel with Q. D. Primer, were specified as coatings for a portion of the Mid-America system to lend lifelong protection against corrosion to the new line. Coal Tar Enamels are the engineering materials of choice where endurance of protection against corrosion is a design requirement.

Reilly COAL TAR PRODUCTS

ARMED Protective Coatings

REILLY TAR & CHEMICAL CORP.

1615 MERCHANTS BANK BUILDING
INDIANAPOLIS 4, INDIANA

TWO RUGGED BARBER-GREENES DOWNTIME PROBLEMS FOR

President and master mechanic report steadier production, less upkeep after 1,400,000-ft of tough trenching...

Excessive maintenance and downtime were stopped cold by the Ohio Pipeline Co., Newark, Ohio, after switching to two Barber-Greene Ditchers—a Model 774 with a 1,000,000-ft record and a smaller Model 772 that totalled 400,000-ft of trench in six months of practically continuous operation.

Oscar Ralston, president of this firm that installs transmission and distribution lines all over Ohio, states: "Both machines have performed very satisfactorily. Dual-range Hydra-Crowd transmission lets our operators keep machines operating at their maximum capacity, regardless of changing soil

ADVERTISED PRODUCTS. SEE READER SERVICE CARD

LICK MAINTENANCE AND OHIO PIPELINE COMPANY

conditions. There's never any radical step-down in forward speed to compensate for tougher digging conditions as is the case with mechanical transmission ditchers."

Master Mechanic Ben Rhodes adds: "On competitive ditchers we've owned, we had plenty of maintenance problems... particularly on discharge conveyors. There were lots of chain, sprocket and idler replacements plus downtime due to chain breakage. We have virtually eliminated this with Barber-Greene hydraulic drives. Maintenance has been mighty low on both ditchers."

See why your Barber-Greene Distributor sells the only modern ditcher line by visiting a job with him. You'll know why owners report from 25-200% more production when you see Hydra-Crowd and these additional features in action: Flexible drawbar between chassis and boom; all-hydraulic spoil conveyor independent of wheel speeds; hydraulic controls for greater line-and-grade holding accuracy; automatic overload protection; and crawler adjustments 10 times faster than on ordinary ditchers.

This 5½-ft Model 774 has won praise of Ohio Pipeline's president, the master mechanic and the operator in digging 1,000,000-ft of trench in 18 months. Can be equipped with 7-ft wheel for 50% less than any other wheel ditcher with this depth capacity.

Ohio Pipeline's Model 772 has narrow track gauge enabling it to work within 19-in. of side obstructions. Trenches 10-24-in. wide and to 5½-ft depths. Model 773 is identical except for wider track gauge and pad width.

Crawler or rubber-tired Barber-Greene Vertical Boom Ditchers cut low cost trench from 5½ to 24-in. wide and to 7-ft deep. Model 784 is shown.

Manufacturer of the only modern ditcher line

Representatives in Principal Cities of the World

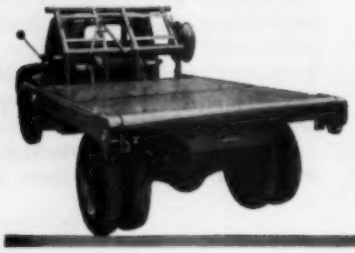
Barber-Greene BG

Main Office and Plant AURORA, ILLINOIS, U. S. A.
Plants in DeKalb, Illinois..Detroit..Canada..England..Brazil..Australia

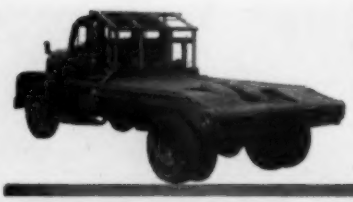
CONVEYORS • LOADERS • DITCHERS • ASPHALT PAVING EQUIPMENT

OVER-THE-ROAD and CROSS-COUNTRY

there's a Leland body for every trucking job



"Packaged Unit" Body — rugged assembly, ideal for winching, hauling, towing, or gin pole work. Also available for 1-ton trucks.



Fifth Wheel Body — readily adaptable to winching, flat-bed work and trailer operations.

Pole Trailers — single axle and tandem, rugged construction means dependable service.

Self-Loading Floats — single axle and tandem, designed for maximum ease of handling by one man.

• Leland's versatile truck bodies deliver maximum pay loads at minimum initial and maintenance costs. For full information contact: Leland Equipment Company, 408 No. Main, Tulsa, Oklahoma, or either of the offices listed below.

Leland also offers you parts and service on such famous name equipment as . . . Cleveland Trenchers . . . Thew-Lorain . . . Gardner Denver . . . C. M. C. . . . Blaw Knox . . . Cedarapids . . . Bros Road Machinery . . . and Tulsa Winches.

35th Anniversary

Leland EQUIPMENT COMPANY

Oklahoma City • TULSA • Longview, Texas

W. E. Mueller

W. E. Mueller, president and board member of Colorado Interstate Gas Company and board member of Colorado Oil and Gas Corporation, has been elected president of the Independent Natural Gas Association of America. Prior to his affiliation with CIG, Mueller was senior vice president and member of the board of Tennessee Gas Transmission Company.

Alva C. Smith, senior mechanical engineer for Mid-Continent Pipe Line Company, has been named director of the Petroleum Activities Committee of ASME. **H. T. Chilton, Jr.,** assistant general manager of Service Pipe Line Company, is program chairman for the transportation division.

Northern Natural Gas Company has reorganized its operating division into six area offices. Vice President **A. L. Vaughan** heads the newly-established operating division and Vice President **W. B. Haas** is in charge of the newly-created construction and engineering division. New area locations and men named as area managers are: **David P. Corkill,** Minneapolis, Minnesota; **Evan M. Griffiths,** Des Moines, Iowa; **Ross N. Cox,** Lincoln, Nebraska; **Otto V. Barbee,** Great Bend, Kansas; **Carl W. Ikard,** Liberal, Kansas; and **Jack W. Seaman,** Midland, Texas. Directly under Vaughan is **Glen Grove,** manager of administrative control.

Two reassignments of location and duty in Texas Eastern Transmission Corporation's Little Big Inch Division include: **Paul G. Doran,** formerly assistant to the general manager, Houston, Texas, now district foreman at Seymour, Indiana; and **Merle S. Greaves,** formerly district foreman at Seymour, now assistant to the general manager, Houston.

New superintendent and assistant superintendent of New York State Natural Gas Corporation's Mamont district are **John L. Holder** and **Wilbur J. Whitehill,** respectively. Holder, former assistant superintendent, succeeds the late Harry J. McNeely, Whitehill was former chief engineer of stations for the district.

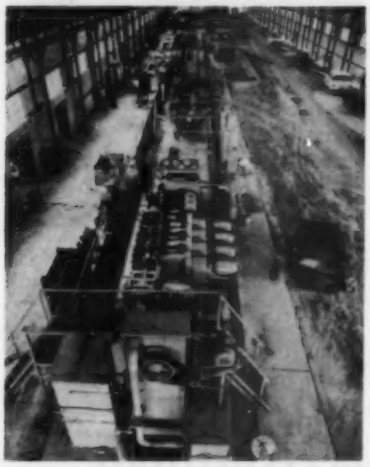
H. T. Chilton

Promotion of **H. T. Chilton,** Tulsa, to the new position of assistant general manager of Service Pipe Line Company has been announced by H. G. Mariner, general manager. Chilton, former maintenance superintendent for Service's 15,000-mile crude oil pipeline system, will head the operating department, which combines operation, maintenance, and construction functions previously handled by two departments. The organizational change follows the retirement of C. W. Butler, operating superintendent, after nearly 41 years with the company.

PIPELINE PARADE

. . . in equipment, services, sales

New Tex-Tube Mill



This new electric-weld pipe mill recently opened by TEX-TUBE, INC., Houston, Texas, to produce 1½ to 5-in. pipe and tubing from coils of sheet steel, is said to have many "firsts" . . . such as individual direct-current drive motors at each stage, or "pass," of the forming and sizing operations; automatic-feeding coil box and strip-leveling equipment incorporated as an integral part of the coil-handling equipment; and new hydraulically-driven traveling cutoff, or flying saw, which travels downstream with the pipe and saws it to length while moving, permitting continuous production at a maximum rate of 165 ft per min. The high-speed mill is housed in an 80 ft by 500 ft steel building. I. Walker Shaw is vice president, production; and Kenneth C. Wooley, vice president, research and development.

Allis-Chalmers Manufacturing Company has consolidated its West Allis centrifugal pump department and compressor department under the management of E. F. Greiwe. C. F. Codrington will be manager of sales and H. L. Ross manager of engineering.

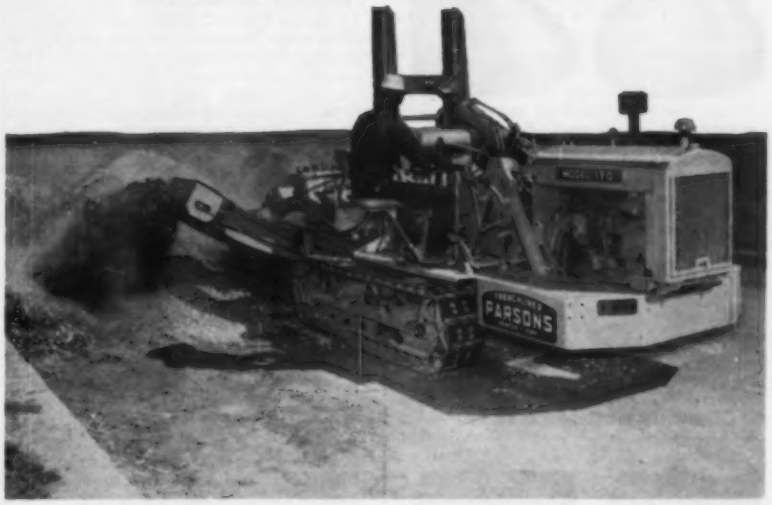
J. Rowland Doyle has been named chief engineer of **The Cleveland Trencher Company,** manufacturer of trench excavating machines and allied equipment. Doyle comes to the company from The Oliver Corporation, where he was assistant chief engineer.

Named to direct ITT Kellogg commercial sales in seven western states and Alaska is Kenneth J. Johnson. As western region manager in Burlingame, California, he succeeds Thomas R. Smith who has been appointed manager of the newly created Hawaiian region. D. S. Copelan has been promoted to manager of administrative services in the communications systems department.

Kraloy Plastic Pipe Company announces the appointment of Robert W. Allison as manager of advertising and public relations.

BIG ENOUGH FOR MAINLINE TRENCHING
SMALL ENOUGH FOR GATHERING LINES

WIDE WHEEL 170 TRENCHLINER



Pipeliners asked for this jack-of-all-trades — Parsons wheel-type 170 Trenchliner®. Extra-wide wheel frame permits trench widths of 20 to 32 inches, at depths to 5¾ feet. Digging speeds range from 12 inches to 25 lineal feet per minute with either gas or diesel engine.

Hydraulic control system on the conveyor gives belt speeds up to 600 feet per minute — independent of digging wheel speed. Hydraulic power also raises and lowers wheel on vertical mast with fractional-inch accuracy for grading and tilts mast for traveling or trailer loading. Mounted on tractor-type crawlers with independent steering, clutches and brakes. Lifetime guarantee for head shaft.

Your Parsons distributor will be glad to give you all the facts about the 170 and other models in the complete line of Trenchliners. Call him today.

P.A.C.

PARSONS HEAVY DUTY

PARSONS COMPANY
NEWTON, IOWA

A Division of KOEHRING Company

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

FLEET-LINE

WELDING FITTINGS

•

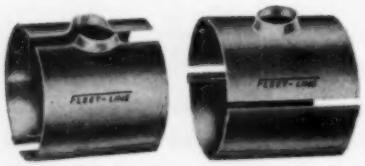
LITERATURE BY AIR MAIL...

...ask for it now.

REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.

SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Full encirclement saddles.



REDUCING TEES, Forged Steel Manifold Type.

Dealers and Stocking Distributors throughout the United States and Canada.

All orders acknowledged by air mail or long distance telephone and filled at once.

STEEL FORGINGS, Inc.

P. O. Box 276A • Shreveport, La.

Pipe Linings, Inc., has named Lee J. Moremen sales manager and appointed Joe R. Williams sales representative to assist Forest E. Foster, Southwest district sales representative, in Fort Worth, Texas, where the company recently erected an office building and warehouse. Moreman formerly was with the company's parent organization, American Pipe and Construction Company, and most recently served as assistant to the president at corporate headquarters in Monterey Park, California.

Lee J. Moremen

New president and general manager of the Parsons Company, trencher manufacturing division of Koehring Company, is J. W. Arnold, formerly vice president in charge of manufacturing for another Koehring division, Hydraulic Press Manufacturing Company. Parsons also has appointed two Michigan distributors: Construction Equipment Company, Detroit, for the eastern part of the state; and O'Neil Equipment Company, Muskegon Heights, for the western part; and The Associated Supply Company of El Paso and for nine counties in western Texas and two counties in southern New Mexico.

Stepping up foreign marketing, Grove Valve and Regulator Company has named as its first full-time sales and service representative for South America Ernest H. Rettig, former technical representative in the project engineering and pipeline construction department of El Paso Natural Gas Company.

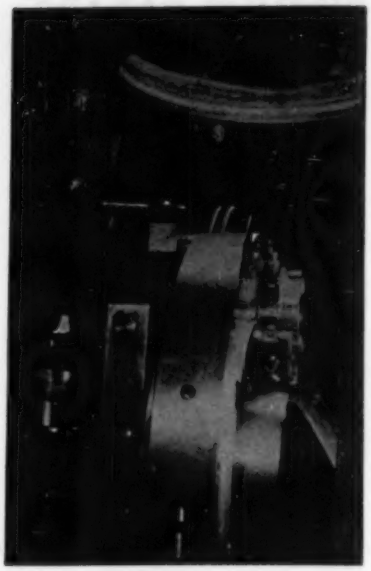
A number of U.S. cities from coast to coast will be visited in the forthcoming fall, winter, and spring months by a microwave and carrier communication system engineering symposium and exhibit being sponsored by the Texas division of **Collins Radio Company.**

Cooper-Bessemer Corporation has named as a sales engineer in its Houston, Texas, branch office Harvey B. Cox, Jr., formerly associated with the Clark Brothers Company in Houston.

Walter L. Scott, Jr., has been promoted from assistant superintendent to superintendent of **The Youngstown Sheet and Tube Company's** No. 3 seamless tube mill at Indiana Harbor Works and is succeeded in his former position by Raymond L. Crowe.

Hellmuth "Dick" Strauss is returning to **Walworth Company** as vice president and general sales manager. He served the company as an executive and board member for more than 25 years before leaving in 1957. Gustav A. Hoffman, a 27-year veteran with the company who left in 1959 while holding the position of assistant vice president in charge of metropolitan division sales, also is returning as vice president, sales.

Pipe Line Chemical Company, Inc., has elected to its board of directors: William A. Craig, Lacy E. Crain, John R. Damminga, Borden Duffel, John N. Jackson, Leb Joyner, Richard E. Kennedy, Claude W. Lyon, Jr., W. J. Roberts, and David Yarbrough. Crain, chairman of the board, also is president of Conco Chemical Company.



...Refinish Crank-Pins ...In Place!

• Accurate High Quality Maintenance And Machine Work

The small engine crank pictured above was restored in close quarters without dismantling engine. Our portable machines can solve your problems and save you money. Crank pins from 5½" through 20" in diameter accurately refinished in place at great saving in cost. **Let us help you minimize down time.**

Worn and damaged flywheel fits refinished in place.

In our shop crankshafts of any size or type completely refinished. Shafts straightened and broken shafts successfully repaired.

Most modern methods used in rebabbitting and machining engine and turbine bearings.

All types of heavy power plant equipment serviced with special attention given to emergency repairs.

Additional information furnished without obligation.

WASHINGTON IRON WORKS, INC.
Established 1876
SHERMAN, TEXAS
Pho. TW—2-8145

New foreign agents appointed to handle overseas sales for **Garrett Oil Tools, division of U. S. Industries,** include: James Bayliss of Brisbane, Australia, in Indonesia, Borneo, Australia, New Guinea, New Zealand, and the Philippines; Edeco Germany, G.m.b.h., of Hamburg, Germany, in West Germany; Anglo-Espanola de Electricidad, S.A., of Barcelona, Spain, in Spain and the Spanish Sahara; Macridge Petroleum Equipment-Supply Company, S. A. L., of Beirut, Lebanon, in Lebanon, Bahrein, Saudi Arabia, Kuwait, Syria, Jordan, Greece, Oman, Neutral Zone, and Qatar; and British Scientific Company of San Fernando, Trinidad, in Trinidad.

In a move to expand production facilities to three times present capacity, **Hydromatics, Inc.,** has acquired 80,000 sq ft of manufacturing space in a complex of buildings formerly occupied by General Electric in Bloomfield, New Jersey.

New vice president and executive head of International Harvester Company's construction equipment division — succeeding retiring Harald T. Reishus — is Robert B. Bradley, president of International Harvester Company of Canada, Ltd.

A. King McCord, president of Westinghouse Air Brake Company, announces the appointment of Charles H. Smith as special assistant to the president to discharge certain functions with respect to the company's European affiliates with operations in France, Germany, Italy, Belgium, Switzerland, and Spain.

Named distributor of Bucyrus-Erie crane-excavators in eastern Oklahoma is **Albert & Harlow, Inc.,** of Tulsa and Ada, Oklahoma.

A sen'or research engineer at Rockwell Manufacturing Company, Harry W. Fisher, has been named manager, central liquid meter products engineering.

Two Caterpillar Tractor Company executives appointed to new responsibilities are: Lloyd J. Ely, from director of manufacturing for domestic operations to vice president of the company's foreign trade group; and Gordon Swardenski, from former assistant manager of the Peoria plant, to Ely's former position.

Elected a director of Universal Oil Products Company is J. D. Stetson Coleman, also a director of Zapata Oil Company. Coleman replaces Carl S. Miner who has resigned and been appointed an honorary director of UOP.

Carl B. Arnold, territorial salesman for **Browning-Ferris Machinery Company** for the past several years, has been made pipeline contractor representative, Dallas, Texas.

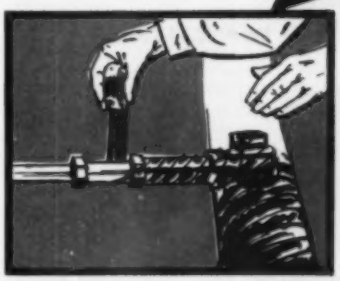
Dr. Van W. Bearinger has been named director of research for **Minneapolis-Honeywell Regulator Company,** filling the vacancy created when Dr. Finn J. Larsen was elected a corporate vice president in charge of research. Named assistant directors are Dr. John N. Dempsey and Edward E. Rexer. Minneapolis-Honeywell also announces the formation of a new corporate division to advance "the state of the art" of complex integrated control systems. The new "special systems division" will be headquartered at Pottstown, Pennsylvania, under John W. Morrison as general manager.

NEE & McNULTY INC.

distributors of

Protecto Wrap

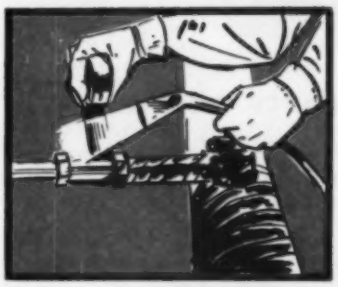
products



200 TAPE (cold application)

Protecto Wrap 200 Tape is a coal tar enamel-synthetic resin coating in tape form. A film of polyvinyl chloride is bonded to the outside of this tape. The addition of this group of synthetic resins to the enamel has upgraded the quality of the tar by increasing its ductility and also by increasing its water and oil repellent characteristics.

This PVC backing provides a tough surface for immediate backfilling and provides an exterior that is highly resistant to soil stress so there is little possibility of soil adhering to it.



STANDARD TAPE (torch application)

There are two kinds of Protecto Wrap Standard, Torch Applied Tapes: No. 110 Standard Coal Tar Tape and No. 120 Standard Asphalt Tape.

In each case, the base material (coal tar or asphalt) is saturated into a glass fabric that acts as a carrier and reinforcement. A paper separator insures even distribution of the coating as well as easy unwinding regardless of the temperature. They are used to form protective coatings for field joints on mill or yard coated pipe, fittings, couplings and other metal surfaces exposed to above or below ground corrosion.

FLOOD COATERS*

Protecto Wrap Flood Coaters consist of inorganic glass fiber impregnated with bituminous pipe coatings of coal tar or asphalt base, with an asbestos felt backing. They are wide enough to include the total bare cut-back where the pipe is welded together, and long enough to cover the circumference of the pipe, plus an additional length to provide over-lap on top of the pipe.

PROTECTO WRAP ALSO MANUFACTURES:

PATCH PADS
CA 160 MASTIC
CA 1180 MASTIC

DISTRIBUTORS OF: CENTRAL PLASTICS: Flange Insulators and Insulated Unions / SEAMLESS RUBBER CO.: Polyethylene Tapes / H & M PIPE BEVELING MACHINE CO.: Dollies, Line Up Clamps, etc. / THERMOWELD: Thermite Connections for Anodes.

*U. S. PATENT NO. 2,721,823

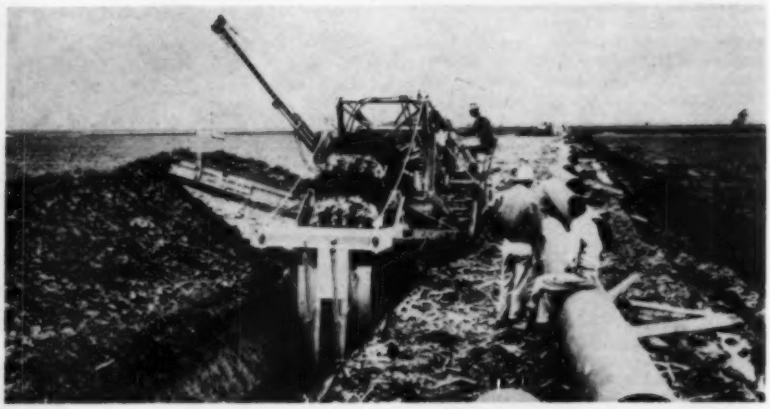
NEE & McNULTY, INC.

TULSA – HOUSTON – DENVER

Engine division, Nordberg Manufacturing Company, announces a new location for Kansas City headquarters. Now at 5812 Roeland Drive, Mission, Kansas, it continues under the management of J. T. Adams, assisted by J. A. Snarenberger, G. Kreher, and C. T. Pierce.

J. Justin Basch and William A. Baltzell have been elected second vice president and vice president, respectively, of **Oakite Products, Inc.** Basch, who has been vice president in charge of marketing since 1958, continues to be responsible for the firm's marketing and research and product development programs. Baltzell continues as industrial sales manager, the post he assumed in 1958.

Motorola Inc. has named Robert H. Davis chief engineer of its microwave department.



KOEHRING SHOW. Some 40 machines were displayed at the annual 4-day Construction Equipment Show of Koehring Company's seven divisions held at Waukesha, Wisconsin. Visitors saw demonstrations of equipment operated under actual job conditions. Pictured here is the improved Parsons 420 wheel type Trenchliner, which has 7-ft 6-in. maximum digging depth and features 21 variable digging feeds from 15.1 in. to 25 ft per min. Digging widths range from 36 in. to 52 in. with sidecutters. Travel speeds are from 86 to 225 ft per min.

A. M. Wiggins, vice president and general manager of **Union Switch & Signal Division, Westinghouse Air Brake Company,** has retired. Robb W. James has been appointed general manager to succeed Wiggins. James formerly was executive vice president of National Pneumatic Company, Inc., and Holtzer-Cabot Electric Motor and Telephone Divisions.

The organization of six construction machinery sales regions within the construction machinery division of **Allis-Chalmers Manufacturing Company** and the appointment of H. T. Larmore to the newly created position of general products manager is announced. Managers of the six sales regions are: J. M. Haile, northwest; G. E. Hall, eastern; A. L. Lowery, central; L. D. Myers, southern; K. A. New, northeast; and J. T. Skinner, western. Appointed the division's assistant general manager is John W. Carlson. Assuming Carlson's former post as general manager of the Deerfield Works is James B. Codlin.

Caterpillar Tractor Company's advertising manager since 1953, Burt M. Powell, has retired and is succeeded by Charles B. Leber. Frank S. Foster replaces Leber as manager of the sales division of the defense products department.

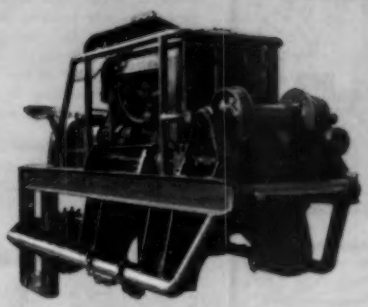
Clayton Mark & Company has promoted William J. Dickman to assistant sales manager of the union division.

Appointed supervisor of electronic switching systems design and development for **Automatic Electric Laboratories** is John G. Van Bosse.

Solar Aircraft Company has promoted Robin Schmidt to director of public relations and advertising and Morris Sievert to manager of turbomachinery sales.

Appointed to the new position of director of administration of **The Thompson-Ramo-Wooldridge Products Company** is Robert J. Barrett, Jr.

C•R•C ROAD BORING MACHINES

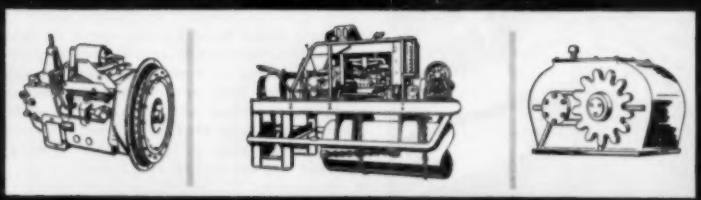


GIVE YOU MORE PROFIT PER JOB!

THESE EXCLUSIVE C·R·C FEATURES MEAN MORE FOOTAGE PER DAY: Faster Hook-Up • Easier Handling • Balance Selector Lifting Eyes • "Unitized" Design For Rugged Dependability—Minimum Maintenance.

C·R·C Road Boring Machines are available in 30" and 42" models.

IMPROVED ENGINEERING AND DESIGN FEATURES FIT THE NEEDS OF THE JOB TO BE DONE!



Funk Revers-O-Matic Drive gives a smooth, shock-free drive, eliminates stalling and lugging.

Pipe saddles are an integral part of "Unitized" frame, adapted to casing with liners, eliminating costly extra parts. Adjustable pull-hooks eliminate need for welding on pusher lugs.

Specially-built heavy duty speed reduction unit.

For faster, more efficient pipeline crossings, put a C·R·C Road Boring Machine on your spread. Write for detailed brochure.

SERVING PIPELINERS SINCE 1933

CRC

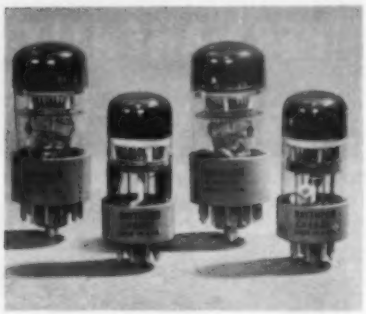
CRUTCHER · ROLFS · CUMMINGS, INC.

Home Office: Houston, Texas, Box 2073, OVerland 6-4301

Export Office: D. T. O'Connor, Inc., 500 Fifth Avenue, New York 36, N. Y., BRyant 9-2236

In Canada: Canadian Equipment Sales & Service Co., Ltd., 7310 99th St., Edmonton, Alberta, Canada

It's New | Pipeline Equipment



Tubes That Count, Display Own Totals

Foreseeing their use in measuring pipeline flow and programming elapsed-time intervals, Raytheon has announced electron tubes called decade counters that count up to 100,000 units per sec and visually display the total on their faces. The tubes record and indicate the count on ten glowing cathodes in luminescent dials within the tubes. With numbered face-plates, placed on series-connected decade counters, the total can be read visually in units, tens, hundreds, etc., during operation. The CK6910 and CK6476 decade counters, operating up to 100 kc and 4 kc respectively, offer electrical readout from any cathode lead; while the CK6909 and CK6802, operating up to 100 kc and up to 4 kc respectively, offer electrical readout at the 0, 5, 8, and 9 cathode leads. *Raytheon Co.*

Circle number (81) on reply card.

New Panel Controls Up to 5 Compressors

A new multi-unit, automatic control panel serves as a single control point for the manual or fully automatic operation of as many as five electric motor driven compressors. In the automatic position, compressors start up and shut down in accordance with a sequence set by the manually operated base unit selector (which also can be automatically operated). No two machines can start at the same time, and each preceding machine must be running before the next unit can start. Compressors unload and shut down in reverse sequence of starting order. By alternate selection of the base unit, even wear is distributed over all compressors, and what would normally be the No. 1 compressor is relieved of continuous duty. Any number of automatic shutdown devices can be tied into the system. The control panel is designed to bring another compressor into operation automatically, should one that is running be shut down because of some malfunction. The panel can accommodate up to five compressors, each with 3-step unloading, or three each with 5-step unloading. *Clark Bros. Co., one of the Dresser Industries.*

Circle number (82) on reply card.

Reports 11 or 17 Faults From Up To 30 Stations

A new completely transistorized fault alarm, developed for Collins microwave systems, uses independent transmitters and receivers for each of upwards of 30 remote stations to report 11 or 17 fault conditions. Transmitter and receiver may be used also for binary data communication or remote control. A transmitter at each remote station continuously scans for faults and simultaneously reports them to its associated receiver at a supervisory station every four seconds by means of a single AM tone. Tones can be set within one of five ranges between 1 and 30 kc. Because tone spacing is at intervals, upwards of 30 separate remote stations can report over a single baseband without interfering with other communications. Both transmitter and receiver display fault reports by means of lights on the front panel, with a separate light for each fault. The receiver also provides a remote alarm signal and has lights for a confidence check on the transmitter and on received data. *Collins Radio Company.*

Circle number (83) on reply card.

• *for fast cleaning of pipe cuts . . .*

• *for accurate placing of lands on pipe bevels . . .*

Patent No. 2,869,293

H&M "BEVEL-LAND" GRINDER

LIGHTWEIGHT! EASY TO OPERATE!

Eliminates Handwork on all Types of Pipe from 6" to 30"

The new H&M "BEVEL-LAND" GRINDER uses an electric or airpowered grinder to prepare pipe for welding by cleaning and smoothing pipe cuts and putting the land on bevels. The GRINDER may be placed in the pipe and in operation in a few seconds. A simple adjustment of the angle of the grinding head is all that is required to change the machine from the cleaning to the land position. The machine is available in two models: one for 6" to 12" and one for 14" to 30" pipe.

Write for Complete catalog of famous H&M equipment

- Pipe Cutting and Beveling Machines for pipe from 1½" to 36"
- Shape Cutter
- Out-of-Round
- Flexible Shaft
- Motorized Units
- Boxes • Pipe Dollies • Clamps • Tongs

H&M PIPE BEVELING MACHINE CO.

311 EAST THIRD ST. Diamond 3-0241

TULSA, OKLAHOMA

Trademark Registered

Another benefit of an Oakite ECP*

One new liquid cleaner does many jobs

OAKITE 202—a new, all-purpose liquid cleaner—is up-to-date proof of just how an Oakite ECP pinpoints the latest research results... gives you more efficient cleaning at less cost.

Whether you spray, mop or brush it on, Oakite 202 is packed with cleaning power. Even when liberally diluted with water, Oakite 202 produces a sudsy solution that cuts fast through grease, grime, caked-on deposits. Yet, it's safe for painted surfaces and fine for brightening up equipment, piping . . . floors, too.

* *OAKITE ECP is a detailed Engineered Cleaning Program developed to fit your particular operation under the experienced supervision of your local Oakite man. ECP covers all your cleaning needs.*

For more details write Oakite Products, Inc., 47A Rector Street, New York 6, N. Y.

OAKITE
over 50 Est. 1909 years' leadership in industrial cleaning
SCIENCE

LD Phone Calls Link Computer "Memories"

Two widely separated computers can exchange information directly over the telephone—while each continues to print out results of calculations—with the introduction of IBM's 1009 data transmission unit designed to link magnetic core memories of solid-state IBM 1401 computers

over regular local or long distance telephone and telegraph lines. Designed for fast, centralized control of dispersed operations, it enables two-way communication between computers at the rate of 150 numbers or letters a second. When telephone company service is used, transmission begins after a dial telephone connection has been established. The data passes from the 1401, through the 1009, into a modulating subset provided by the local telephone company, and over the communications line. At the receiving station, it passes through a demodulating subset and the 1009 into the core storage of the 1401. While information is being transmitted and received, both 1401 systems are free to perform simultaneous tape-to-printer operations. When not in use for sending or receiving, the 1401 can be used for full data processing operations. *International Business Machines Corp.*

Circle number (84) on reply card.

Anti-Vibratory Liquid Level Control

To provide dependable liquid level control in pipeline applications where vibration and corrosion are serious problems, a new single-stage, external-float-cage liquid level control has been introduced. A principal design aim: to provide an anti-vibratory, corrosion-resistant liquid level control as a high-level alarm on scrubber service with 0.6 specific gravity hydrocarbon liquid at 500 psi, with high ambient temperature conditions. Magnetrol's new model 752 can be equipped as either an electric or pneumatic control. A new magnet-actuated, two-position, snap-action mercury switch is anti-vibratory; and the angle of the magnet "swing" has been increased to provide greater angle or tilt to the mercury switch, eliminating any splashing of mercury across contacts under most severe vibration conditions. *Magnetrol, Inc.*

Circle number (85) on reply card.

REPAIR PIPE LEAKS
QUICKLY PERMANENTLY
ANY PRESSURE
ANY TEMPERATURE

SKINNER-SEAL
EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

SKINNER-SEAL
COLLAR LEAK CLAMPS—for oil and gas lines. Gasket is sealed by gasket container rings—pressure is sealed in . . . air, moisture and gasket-destroying soil conditions are sealed out. Effective under any pressure. Sizes 2"—13" O.D. incl. In stock at oil supply stores!

For over half a century, a complete line of Repair Clamps and Saddles for steel and cast iron pipe. Send for catalog!

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

Total Computer Control System

Now available for a broad range of applications including pipelining is a new, completely integrated computer control system subject to a single responsibility for concept, equipment, installation, service, maintenance, and the training of personnel in its operation. Nucleus of the system is the general-purpose, all-solid-state Honeywell 290 digital computer. Typical operating rates of the computer are 8000 additions or subtractions, 1250 multiplications, or 400 square root extractions per sec. including memory access time. Both binary and decimal arithmetic are used by the computer. High computation speed is due to parallel operation, in which computer "words" are transferred simultaneously from one element to another instead of serially or singly, a low clock rate (50,000 cycles per sec) governing operation time, and unique control design. *Minneapolis-Honeywell Regulator Co.*

Circle number (86) on reply card.

Fuel Filter

A compact fuel filter, consisting of a pre-formed cellulosic element that is accordion pleated, provides greater filtering area, for such light hydrocarbons as gasoline, avgas, jet fuel, and diesel fuel. Weighing slightly over 10 lb, and 13 in. in length and 7½ in. in diameter, the PAG 25-D filter can be installed on stationary fuel dispensing stations at the terminal point of pipelines and can operate effectively at a maximum operating pressure of 25 psi and a maximum operating temperature of 200 F. The filters can be mounted as "line" type or on brackets when used on diesel engines. *Purolator Products, Inc.*

Circle number (87) on reply card.

Vertical Air Compressors

Two new compact heavy-duty air compressors are available — a two-stage LB model for pressures to 1000 psi and ranging in size from 50 to 120 cu ft per min, and a single-stage model LA for pressures to 125 psi and from 71 to 240 cu ft per min. Maximum interchangeability is realized by using the same parts on all comparable sizes. A new water cooling design is said to afford more efficient use of power; a gear driven rotary oil pump assures positive pressure lubrication system; and aluminum pistons provide less weight, improved balance, and less vibration. Crankcase and cylinder are separate components. *Gardner-Denver Co.*

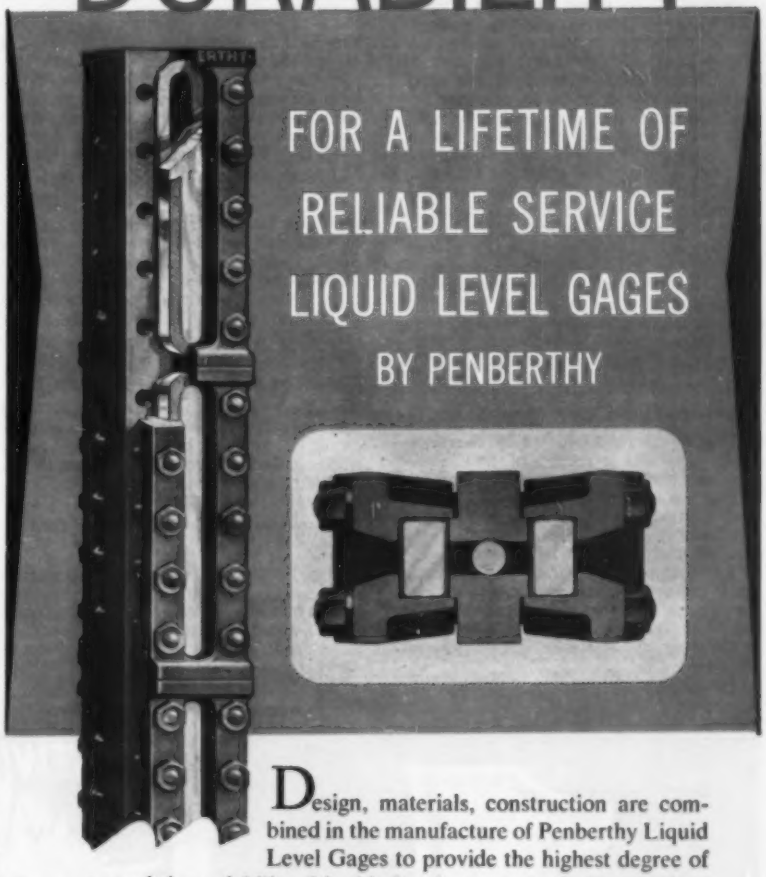
Circle number (88) on reply card.

Solid-State Scanning

Allowing completely unattended operation of pipeline installations is a new solid-state "Electronic Scanning System" which uses no relays, stepping switches, motor-driven commutators, or rotating switches to perform monitoring, alarm, and remote station on-off control functions from a central station. The Lynch B-1000 series utilizes a form of time-division multiplexing which codes each function and repeats it continuously at rates up to 3000 "bits" per second; and provides up to 36 separate functions, which may be transmitted over a single pair of wires. *Lynch Communications Systems, Inc.*

Circle number (89) on reply card.

DURABILITY



Design, materials, construction are combined in the manufacture of Penberthy Liquid Level Gages to provide the highest degree of rugged dependability. Liquid chambers are made in one piece from a solid bar of carbon or alloy steel and precision heat treated, machined and ground . . . for perfect, leak-tight alignment and rigidity. Covers, of temperature resistant steel, completely enclose sides and ends of glass and gasket . . . for blowout prevention. Pyrex glass is used exclusively . . . for its greater strength and resistance to shock and erosion. Even the gasket material is specially selected . . . for its high resiliency and ability to withstand excessive compression. In brief . . . For *lasting* accuracy in a liquid level gage, look to Penberthy.

PENBERTHY MANUFACTURING COMPANY
Division of Buffalo-Eclipse Corporation
PROPHETSTOWN, ILLINOIS
SALES OFFICE: 2660 E. GRAND BLVD., DETROIT 11, MICH.

PENBERTHY
Dedicated to Quality Since 1886

GENTLEMEN: Want complete details on your liquid level gages. Please send Catalog #36 immediately.

NAME _____ TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Bevel Gear Operator

The new "Converto-Gear Operator"—designed to provide power-assist in opening and closing iron and steel O.S.&Y. and non-rising stem gate valves having stem diameters of 2½ in. or less—uses a bevel gear with a 4.11 to 1 ratio and is adaptable for either pneumatic or electric power wrench operation and for either vertical or horizontal valve installations. The valve can be converted and the operator installed in less than 30 min, while the valve is in service and using commonly available hand tools and wrenches. To add the "Converto-Gear Operator" to O.S.&Y. valves with ball bearing yokes: remove handwheel; slip on yoke sleeve adapter; position operator adapter and mark for countersinking four holes in yoke; and bolt operator to adapter. To convert non-rising stem valves: remove handwheel, gland and stuffing box; install bonnet adapter; insert stem adapter; and position and bolt operator. *Crane Co.*

Circle number (90) on reply card.

Provides 36-Day Record

A new cartridge-type strip chart recorder provides a record of flow, pressure, and temperature measurements for periods up to 36 days without attention. Each cartridge—including chart, storage spool and rewind spool—is removed as a unit, so that chart changes can be made in a few seconds. No re-threading at the site is required. The cartridge will fit into the American chart integrator for fast chart interpretation. Chart speeds are available from ½ to 6 in. per hr. *American Meter Co.*

Circle number (91) on reply card.

It's New | Pipeline Literature

Engine Pamphlet . . . on 27 diesel and carbureted engines in four, six, and eight-cylinder versions . . . available from stripped engines to complete power units, with horsepower ratings ranging from 16.4 to 385, and weights from 279 to 6045 lb. *International Harvester Co.*

Circle number (92) on reply card.

A Chart Integrator . . . for interpretation of American strip charts and conventional round charts, and convertible from use with one to use with the other by means of a simple adaptor plate supplied with the instrument . . . is described by a new bulletin. *American Meter Co.*

Circle number (93) on reply card.

Ratings, Typical Applications of General Electric's new gyro-integrating mass flowmeter . . . in a new bulletin highlighted by a discussion of converting from volumetric to mass flow measurement in various applications. *General Electric Co.*

Circle number (94) on reply card.

"When To Use A Controller" is explained in a new catalog of pneumatic pressure and temperature controllers that control pressures up to 10,000 psi and temperatures from minus 125 F to plus 1000 F. *OPW-Jordan Corp.*

Circle number (95) on reply card.

"Joy-Stick" Controls of the convertible Lorain 50 crawler-mounted shovel-crane are described in a 2-color booklet detailing construction features that also include square-tubular-chord-boom and oil-enclosed travel mechanism. The machine is photographed in action. *The Thew Shovel Co.*

Circle number (96) on reply card.

"New —From Track Shoes To Boom Tip" is the way a new illustrated catalog describes the air-controlled American 900 Series crawler crane-excavator of the 3½ to 4½-cu-yd class with rated lifting capacity of 110 tons. *American Hoist & Derrick Co.*

Circle number (97) on reply card.

Corrosion Resistant Pipe Wrap for protecting pipelines . . . specifically laminated butyl rubber and plastic tape in combination with a butyl base primer . . . is the subject of a new 10-pager in color. It contains full specifications in Plicoflex tape and illustrates its uses. *Plicoflex, Inc.*

Circle number (98) on reply card.

Two-Way Radio brochure . . . containing explanations and illustrations of the benefits of transistors in the "Motrac" line. *Motorola, Inc.*

Circle number (99) on reply card.

1st
IN CORROSION PREVENTION
BITUMASTIC
REG. U. S. PAT. OFF.
HOT & COLD APPLIED COATINGS
Carey
PIPELINE FELT, PADDING & GLASS PIPE WRAP
TAPECOAT
PIPE JOINT PROTECTION
MAVOR • KELLY COMPANY
M & M BUILDING • HOUSTON • CA 2-2203
6000 1038 4th Street • Gretna, La. • FOrest 1-1861

MOUNTS AND CUTS ON SHORT LENGTHS OF PIPE!
For a welcome distinctive change in pipeline equipment, Mathey is proud to announce their newly designed Pipe Beveling Machine. It's extremely lightweight and requires only ½ the storage space. No. 1-SA machine can be operated on pipe segments as short as 9" and still cut 1" off pipe. In larger models weight is proportionately lighter.
Call or Write for Further Information or Demonstration.
C. A. Mathey MACHINE WORKS, INC.
212 So. Frankfort Tulsa, Okla. • Box 1159 • Gibson 7-3311

Erase Your Pipeline Protection Problems with this Four-Point PITT CHEM Enamel Program!

COMPLETE QUALITY CONTROL

As a basic producer, Pittsburgh maintains rigid quality control standards at every step of enamel production, from coal to finished coating—your guarantee of consistently superior quality. Today, *Pitt Chem* Pipeline Enamels protect thousands of miles of gas and petroleum product transmission and distribution lines from coast to coast!

WRITTEN SPECIFICATIONS

Published to assure you uniform top quality and performance from every drum of *Pitt Chem* Pipeline Enamels—in application and in service.

EXPERIENCED SALES SERVICE

Pitt Chem sales representatives are experienced coating men. They talk your language, will help you plan the many requirements of your coating job.

TECHNICAL FIELD SERVICE

Pittsburgh maintains a full time staff of field service men to work with your field men in the efficient, economical application of coatings. *Write us about your protection requirements!*

- PITT CHEM® Coal Tar Pipeline Enamels
- PITT CHEM "Insul-Mastic"® Gilsonite-Asphalt Coatings
- PITT CHEM "Tarset"® Coal Tar-Epoxy Resin Coatings
- PITT CHEM "Tarmastic"® Coal Tar Coatings

PROTECTIVE COATINGS DIVISION

PITTSBURGH CHEMICAL CO.

GRANT BUILDING PITTSBURGH 19, PA.

A Subsidiary of PITTSBURGH COKE & CHEMICAL CO.

1194

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

McCORD

Type "C" CHEMICAL

EXTREMELY ACCURATE DEPENDABLE

MEASURING PUMP

Accuracy of delivery in McCord chemical pumps is the result of a finely engineered design with a minimum number of parts. Dependability is insured because working parts are fully enclosed, protected from dirt and the elements. Specify McCord. For sale by National Supply Co.

Lubricator Division

McCORD CORPORATION

Detroit 11, Michigan

An Automatic Lubricator for lubricated plug valves . . . how it is constructed, how to install and operate it, and information necessary for its adjustment . . . are discussed in a new bulletin. *Rockwell Manufacturing Co.*
Circle number (100) on reply card.

Why, How, What of electromagnetic drives. An illustrated 12-pager describes how they work, what they include, and where they are used. The excitation system, optional operating functions and mechanical features associated with the various types also are reported in detail. *Westinghouse Electric Corp.*
Circle number (101) on reply card.

Reprint of a paper originally presented at the ASME Gas Turbine Power and Hydraulic Conference in Houston, Texas, to present a 9000-hp single shaft gas turbine built by Clark Bros. The 10-pager is in color and illustrated throughout. *Clark Bros. Co., One of the Dresser Industries.*
Circle number (102) on reply card.

"The New Design In Control Equipment" is the title of a new 4-pager, illustrated with a fully-explained arrangement diagram of a custom design system. *International Controls Corp.*
Circle number (103) on reply card.

Specification/Work Range bulletin on backhoe attachments and options for crawler-mounted, carrier-mounted, and self-propelled crane-excavators. *Schield Bantam Co.*
Circle number (104) on reply card.

Waterless Hand Cleaners . . . finding increasing use in many occupations, particularly where fresh water is limited . . . are the subject of "Current Topics No. 146." Formulations of three typical types and their preparation are described. *Sonneborn Chemical and Refining Corp.*
Circle number (105) on reply card.

Heat Transfer Catalog comprehensively covers in 32 pages Young radiators, heat exchangers, and supercharger air coolers, with installation photos, and presents scientific, nuclear heat transfer applications to meet requirements of the atomic era. *Young Radiator Co.*
Circle number (106) on reply card.

Fiber Glass Components . . . their innate strength, corrosion resistance, and dielectric properties . . . and the plant facilities which produce them . . . are described in a new bulletin. *Warminster Fiberglass Co.*
Circle number (107) on reply card.

Write for Bulletin

PIPELINE VENTS AND MARKERS

FLEET-LINE CO.
P. O. BOX 276-A
SHREVEPORT
LOUISIANA

Spy Detector

. . . our SPY HOLIDAY DETECTORS are as near as your telephone—in fact, in emergencies our own plane assures immediate service.

Rugged equipment for dependable holiday detection on ¾" to 36" pipe . . . signal—bell, light and spark . . . unaffected by dew or frost.

Call, wire or write.

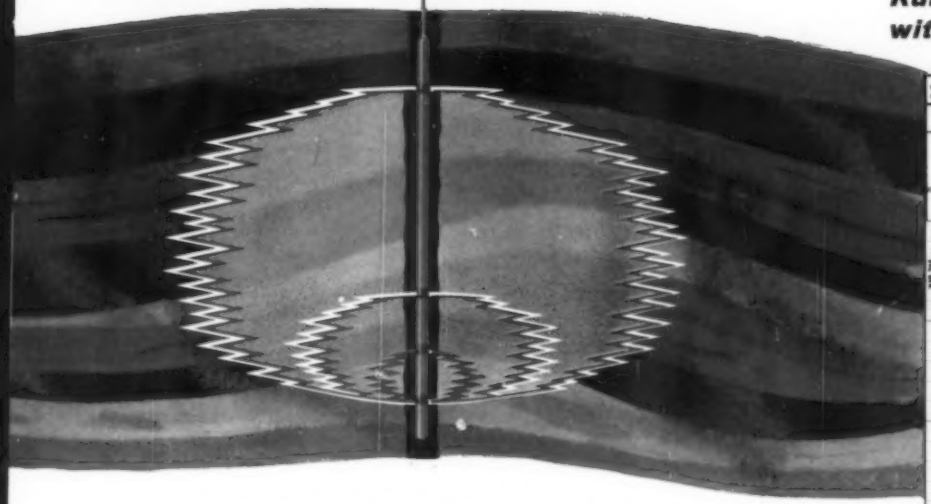
Pipeline Inspection Co., Inc.
2104 WYANDOTTE STREET • KANSAS CITY, MISSOURI

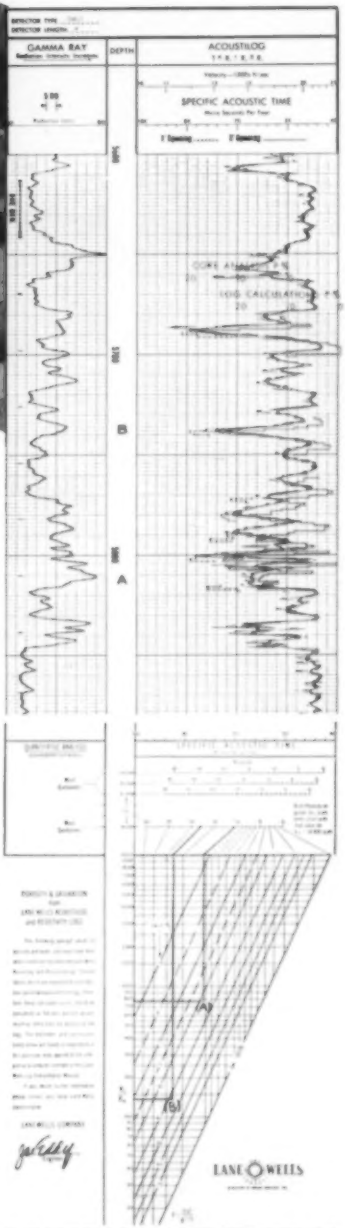
Day Phone: BAltimore 1-6036
Night Phone: HI 4-6745, EM 1-3824

Another FIRST by LANE-WELLS

DUAL SPACED ACOUSTILOG*

Run SIMULTANEOUSLY with Gamma Ray or SP





Lane-Wells Dual Spaced Acoustilog is the most accurate, most meaningful, most informative, quickest run log of this type available anywhere. All new instruments, offered exclusively by Lane-Wells, make it possible to run both 1′ and 3′ spacing curves plus either a self potential or a gamma ray curve all on one trip into the well.

Provides Most Meaningful, Most Accurate FORMATION EVALUATION

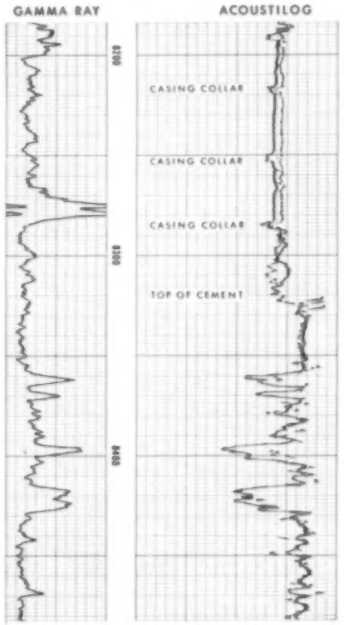
MOST MEANINGFUL!—Because both the 1′ and 3′ curves are recorded while the instrument is in the same position in the borehole, the differences in readings are significant and reliable. Porosities may be read accurately directly from the log. **MOST ACCURATE!** — Exclusive design and circuitry features of Lane-Wells Dual Spaced Acoustilog enable it to measure sound velocities within ±2% of known formation velocities.

PLUS–CEMENT LOCATION

Dual Spaced ACOUSTILOGS have proved remarkably valuable in locating cement and channeling behind casing. Even in areas where other cement locating equipment fails, Acoustilog gets the information.

For complete information about how the all new Dual Spaced Acoustilog can save you money and give you more information about your well, call your nearest Lane-Wells office or write P. O. Box 1407, Houston 1, Texas.

*Lane-Wells Service Mark



Acoustilog used to locate cement.

LANE-WELLS CO.
HOUSTON, TEXAS
LOGGING · PERFORATING · PACKERS · BRIDGING PLUGS

DRESSER INDUSTRIES, INC.
OIL · GAS · CHEMICAL · ELECTRONIC · INDUSTRIAL

ONE OF THE DRESSER INDUSTRIES

You're AHEAD with Lane-Wells' Superior Service

DUAL PUMP POWER

In today's deeper completions rugged reserve power is required for successful fracturing and cementing. When you send Halliburton to service your well, chances are the trucks will be equipped with *two* of the industry's mightiest power packages . . . the twin T-10 or the HT 400. Only with Halliburton do you always get Dual Pump Power which means dual pump *dependability*.
Dual Pump Power is not new with us. To meet your requirements we've been providing it for over 35 years.

Halliburton COMPANY
DUNCAN, OKLAHOMA